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(54) **ENDOSCOPIC SURGICAL CLIP APPLIER**

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CPC ***A61B 17/1285*** (2013.01); *A61B 2019/4836* (2013.01); *A61B 2019/4873* (2013.01)

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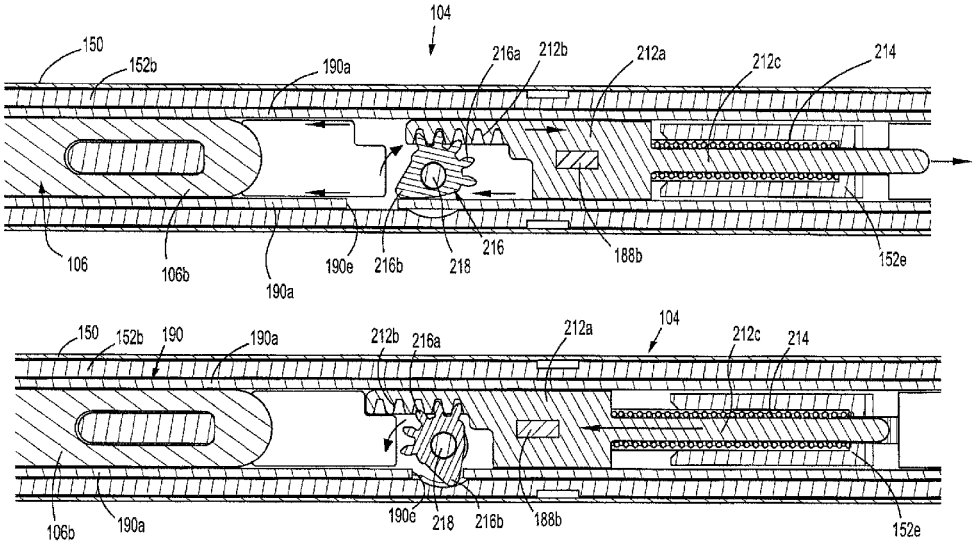
(57) **ABSTRACT**

An apparatus for application of surgical clips is provided and includes a lockout system selectively engageble with a pusher bar to prevent the pusher bar from returning to a home position and to prevent a trigger from completing a full stroke when a plurality of clips are substantially exhausted. The apparatus may include a trip mechanism including a trip lever biased into contact with the pusher bar, wherein distal movement of the drive bar moves the trip mechanism until the trip lever engages a lip of the pusher bar and in turn distally moves the pusher bar. The apparatus may include a wedge plate including a distal end placeable between spaced-apart jaw members, wherein the wedge plate is moved proximally to withdraw the distal end thereof from between the jaw members when a drive channel is moved in a distal direction.

18 Claims, 44 Drawing Sheets



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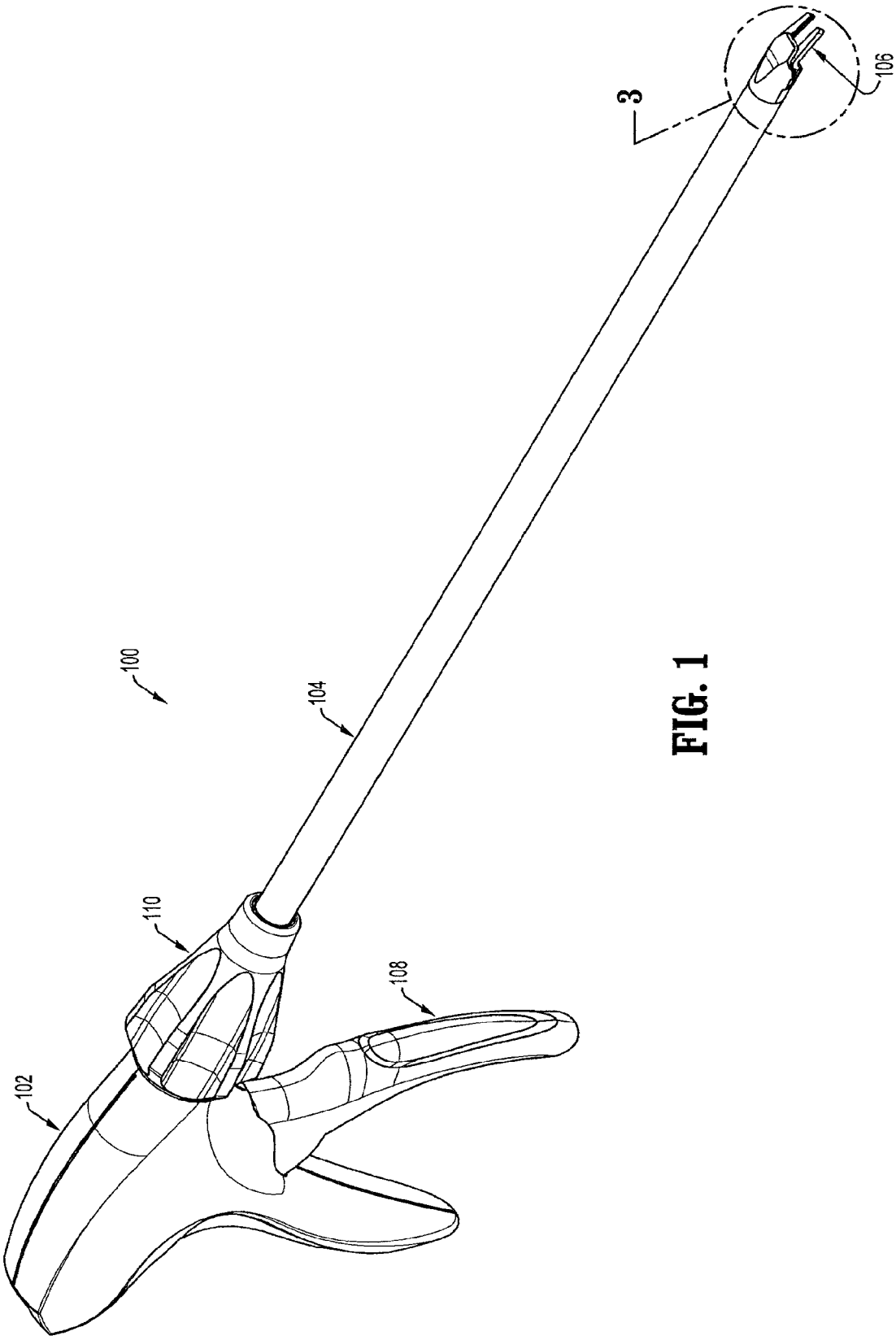


FIG. 1

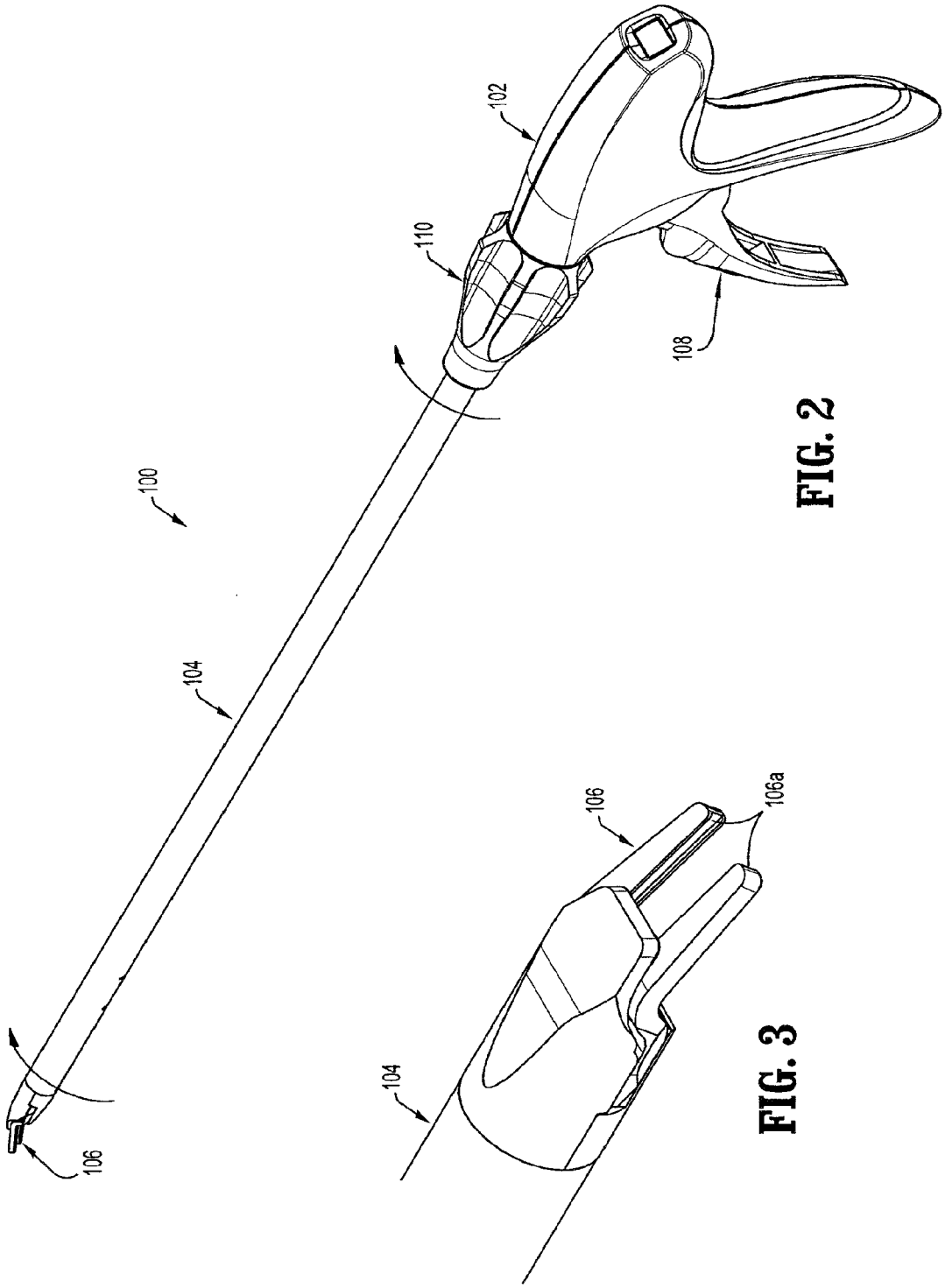


FIG. 2

FIG. 3

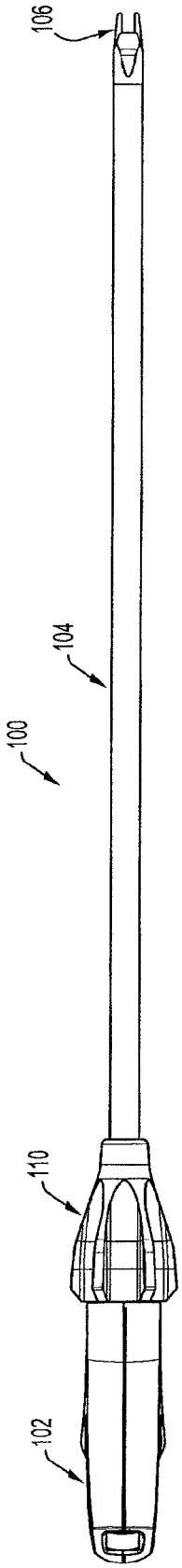


FIG. 4A

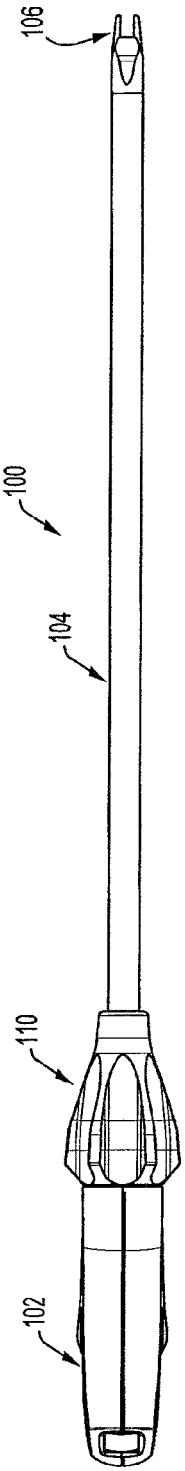


FIG. 4

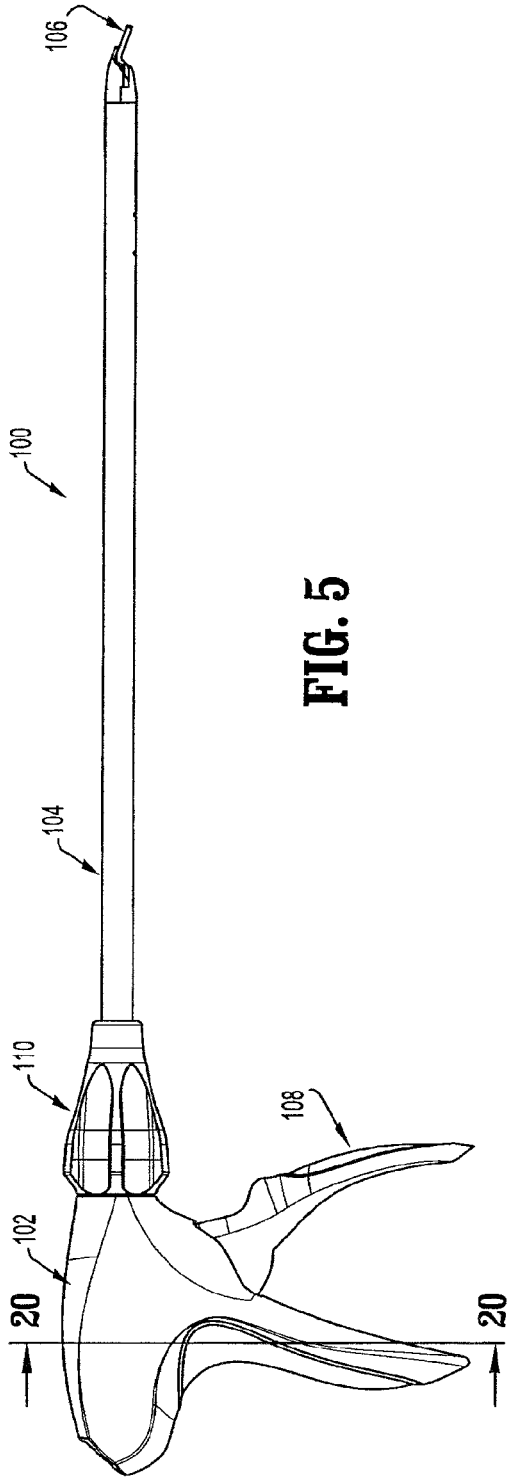
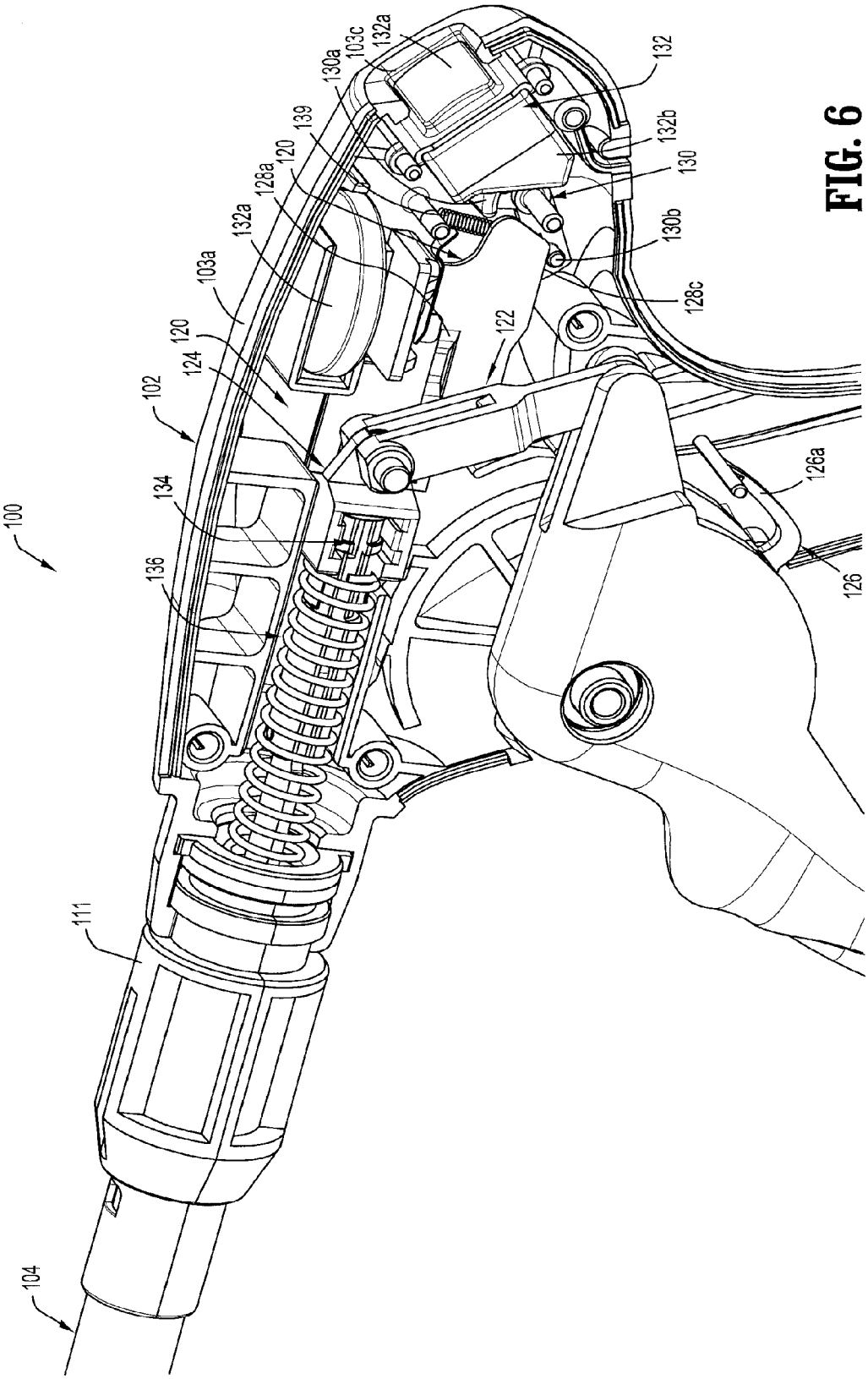


FIG. 5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111
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126a
128a
128c
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130a
130b
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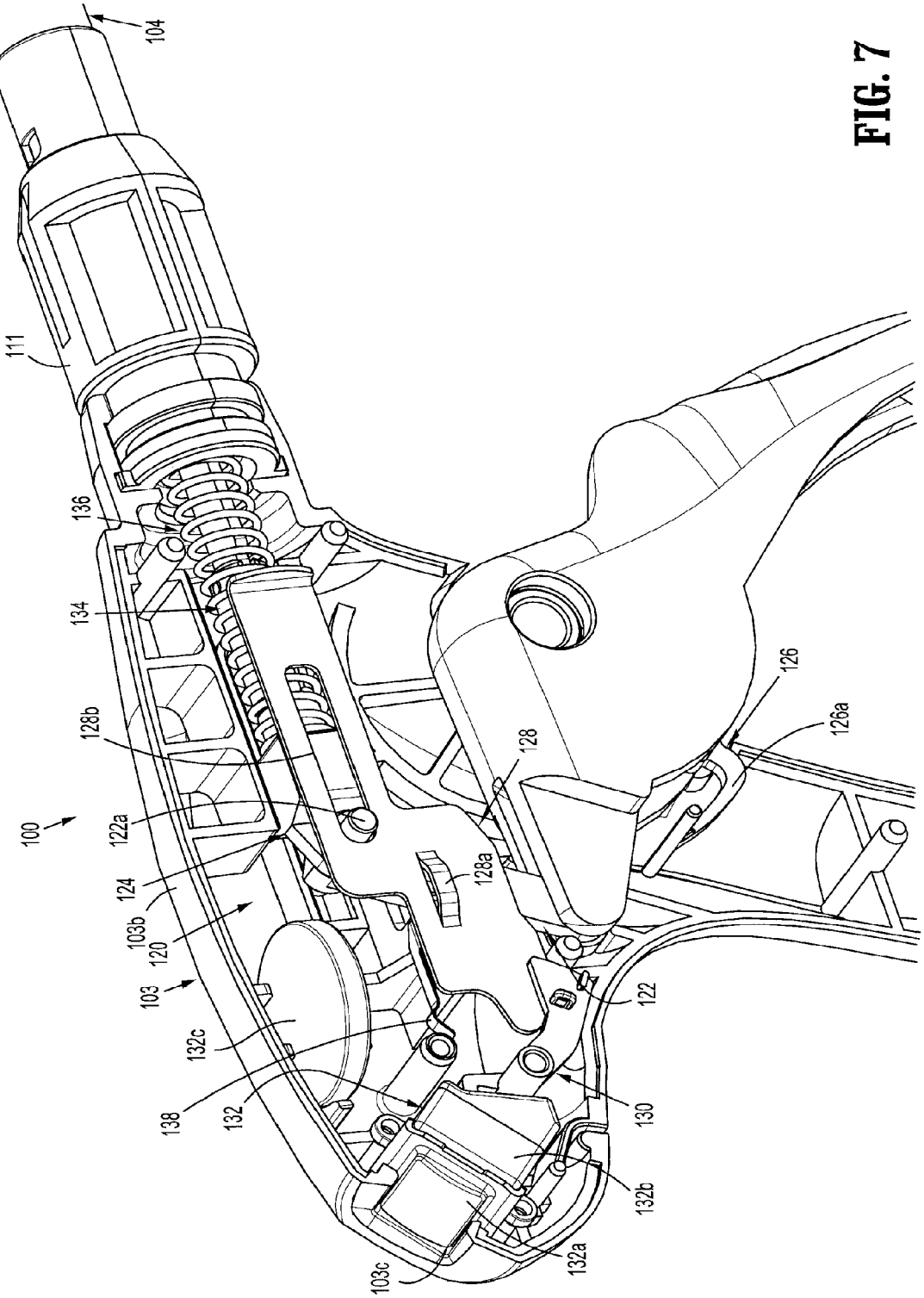
132a
132a
132b
134
136
139

FIG. 6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128b
122a
124
103b
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132c
138
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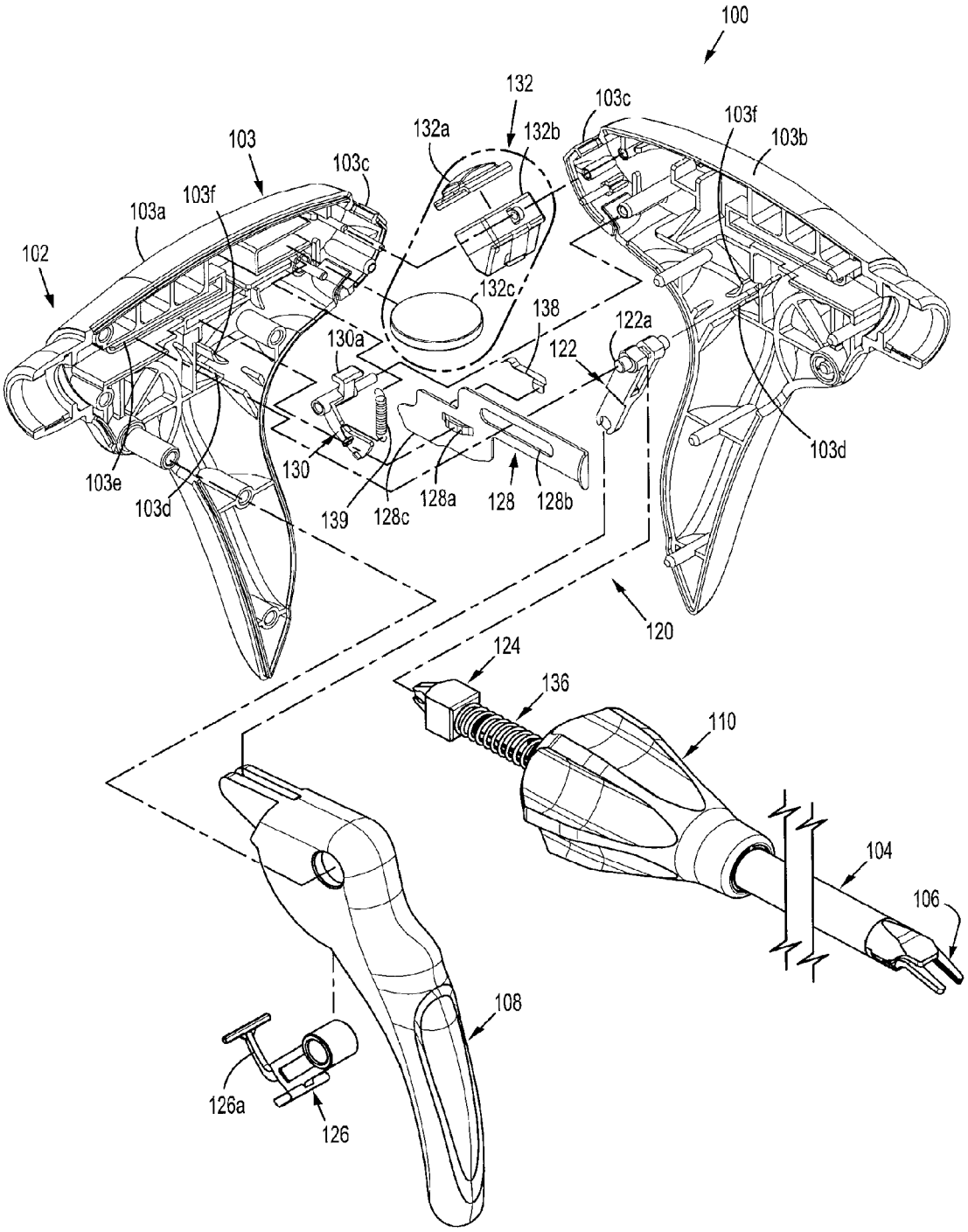
100
128
128a
126
126a
122
130
132b
132a
103c

FIG. 7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132
103c
103f
103b
132a
132b
103
103c
103a
103f
102
132c
138
122a
130a
122
103d
103e
103d
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139
128c
128a
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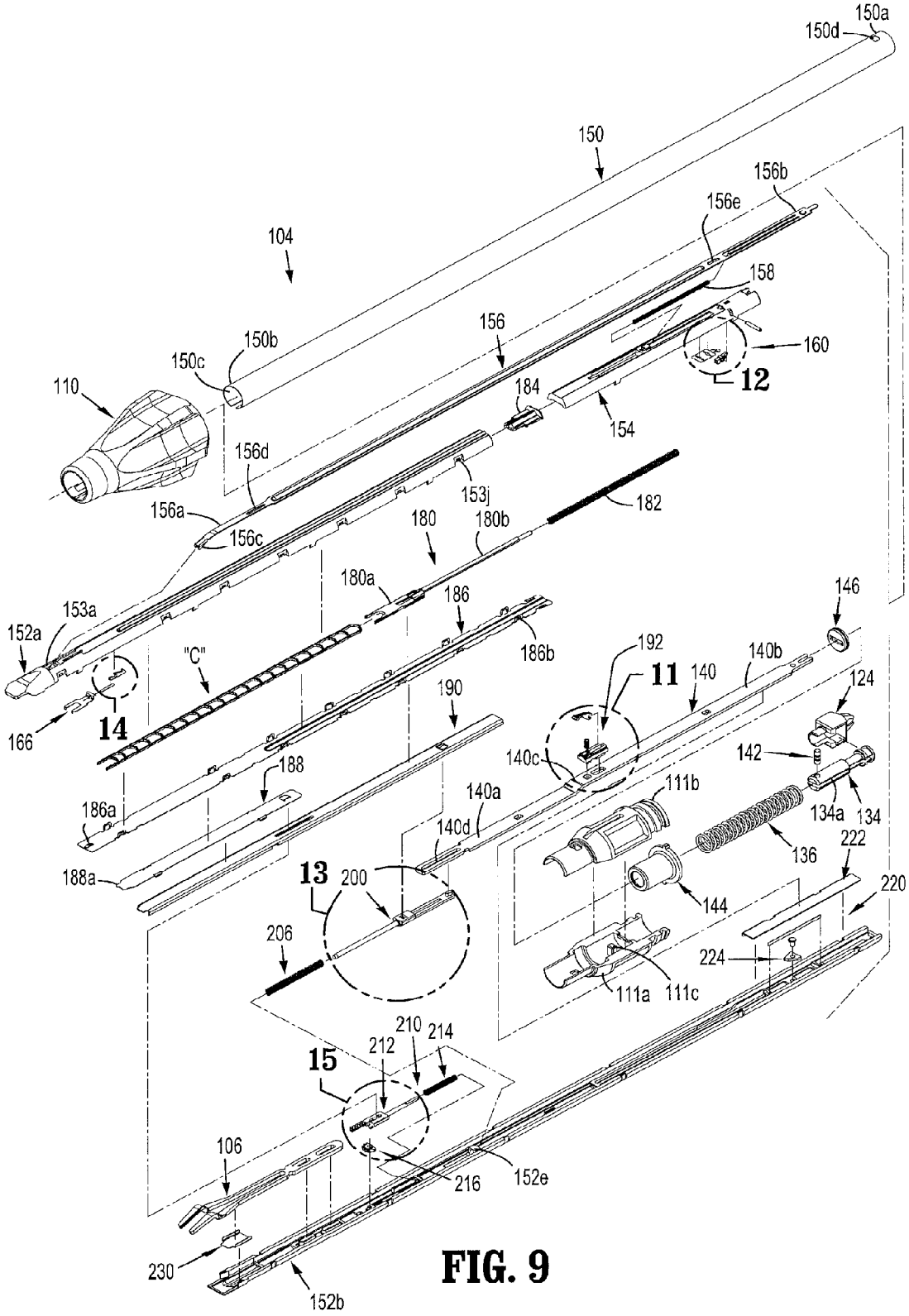
128b
120
124
136
110
104
106
108
126a
126

FIG. 8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150d
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156b
156e
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156
150b
150c
160
12
110
184
154
156d
153j
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156a
156c
180
180b
180a
186
146
153a
152a
186b
192
"C"
11
140
140b
124
14
190
166
140c
142
188
111b
140a
186a
134a
134
140d
136
222
13
200
188a
144
220
206
224
111a
111c
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214
212
15
106
216
152e
230
152b

FIG. 9

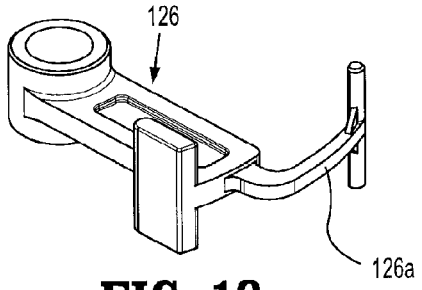

FIG. 10

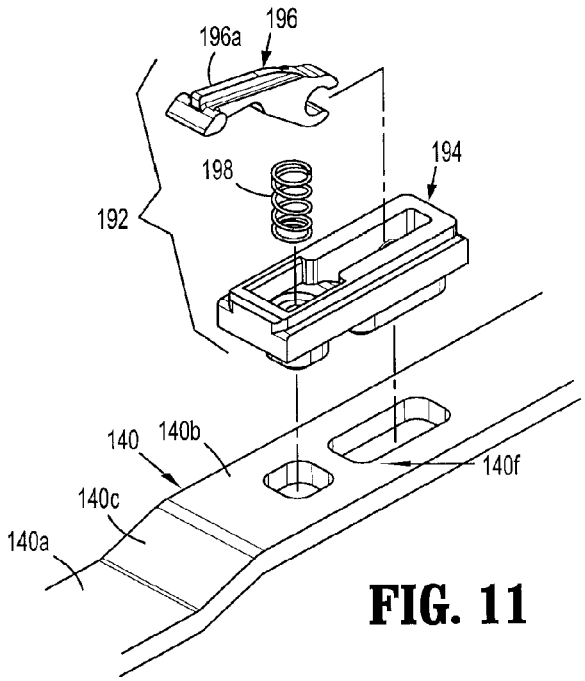

FIG. 11

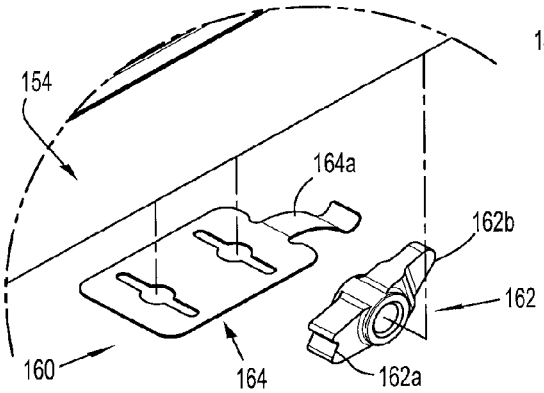

FIG. 12

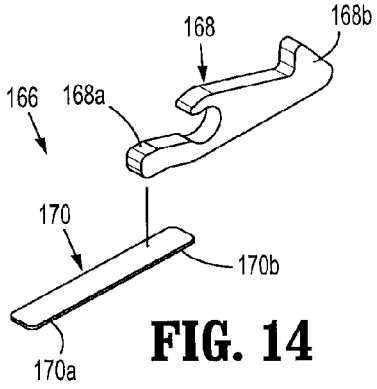

FIG. 14

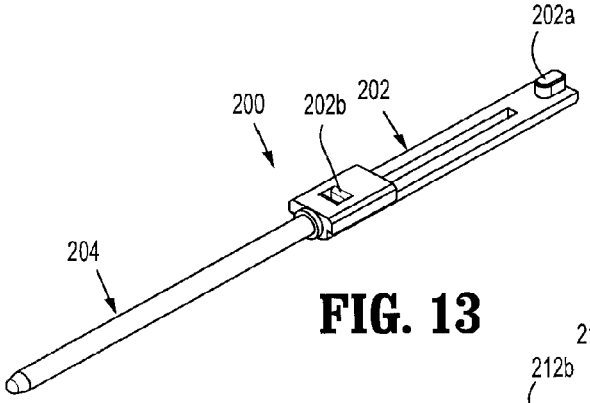

FIG. 13

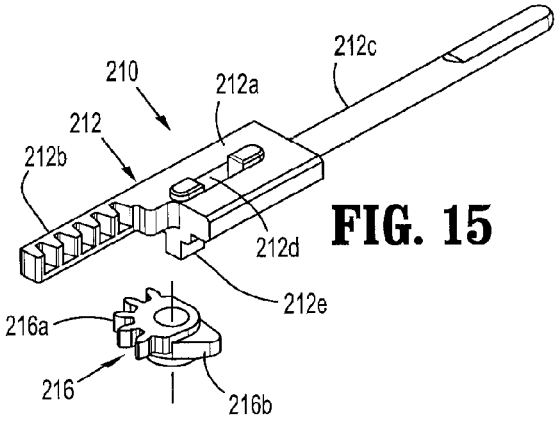

FIG. 15

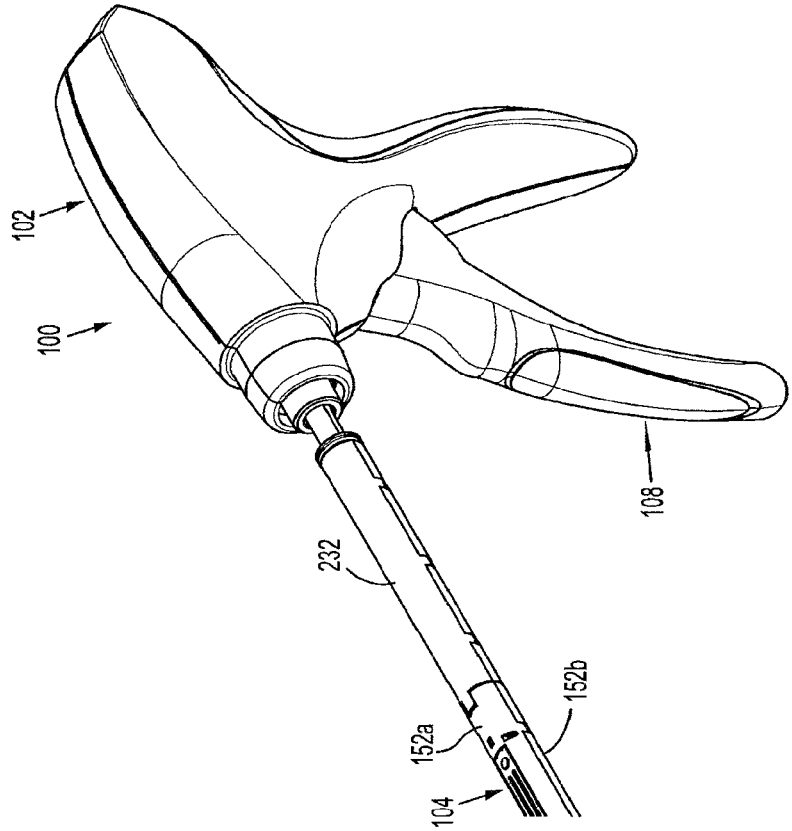
102
100
108
232
152b
152a
104

FIG. 17

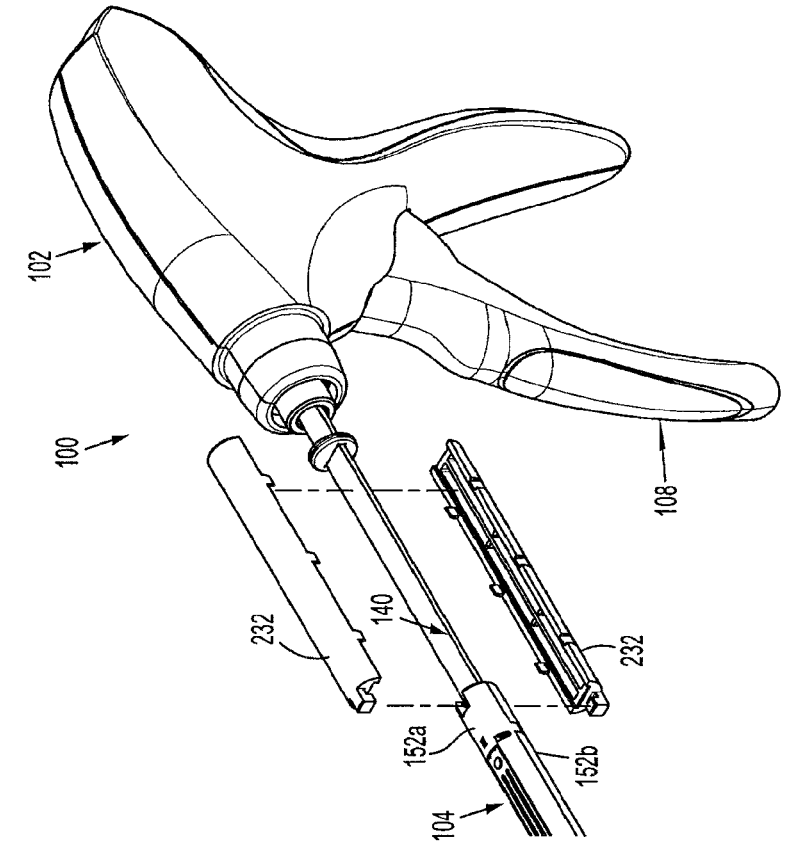
102
100
108
232
140
232
152a
152b
104

FIG. 16

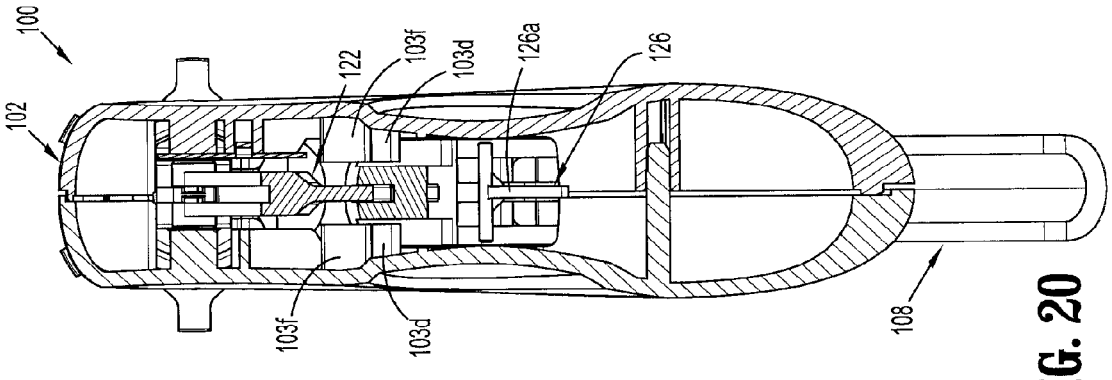

FIG. 20

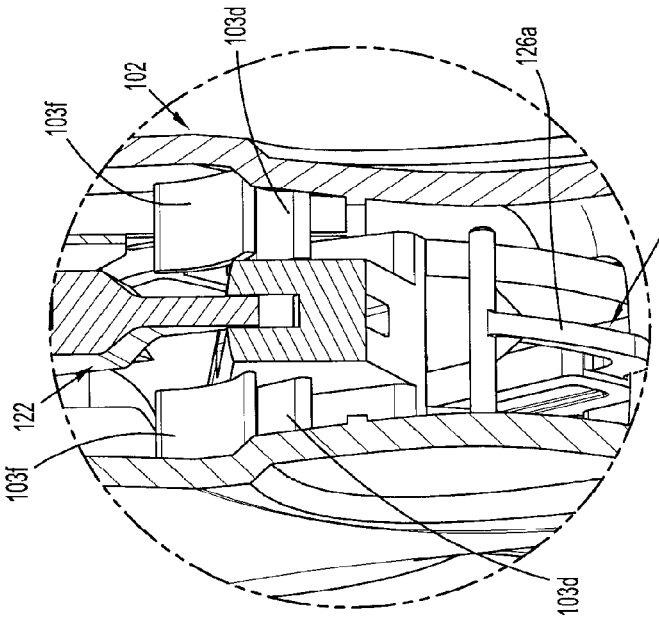

FIG. 19

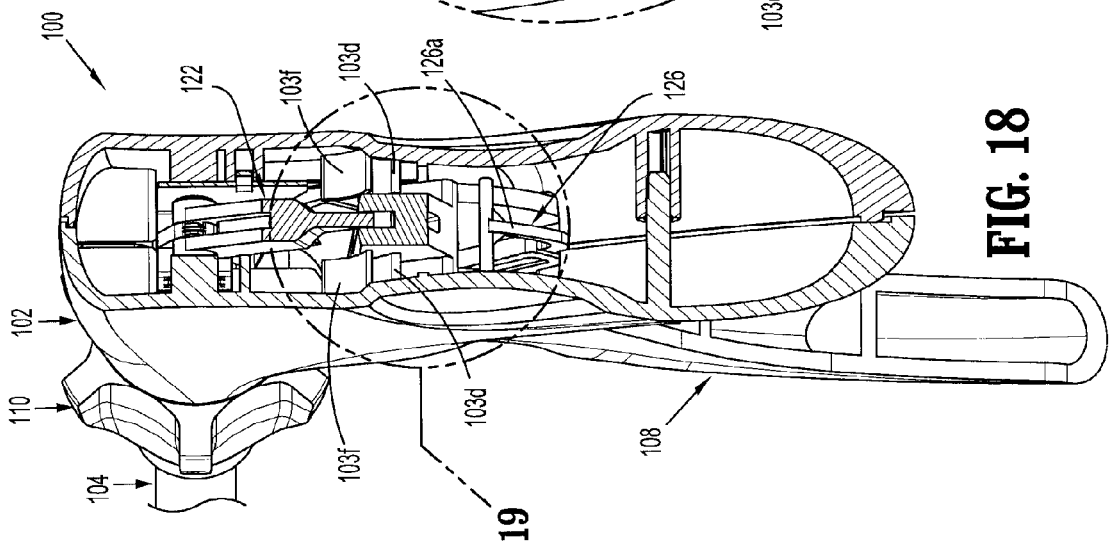

FIG. 18

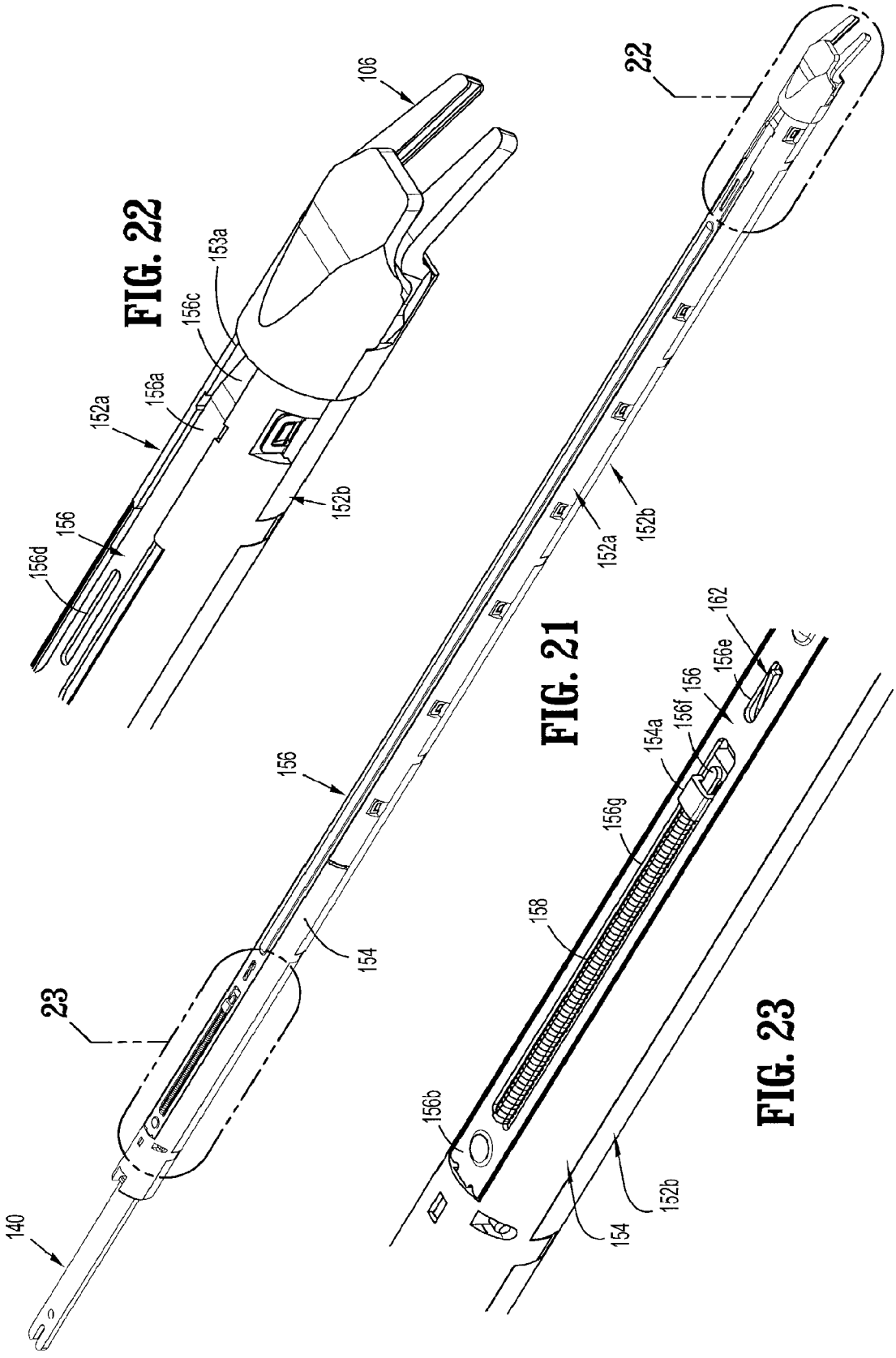

FIG. 22

FIG. 21

FIG. 23

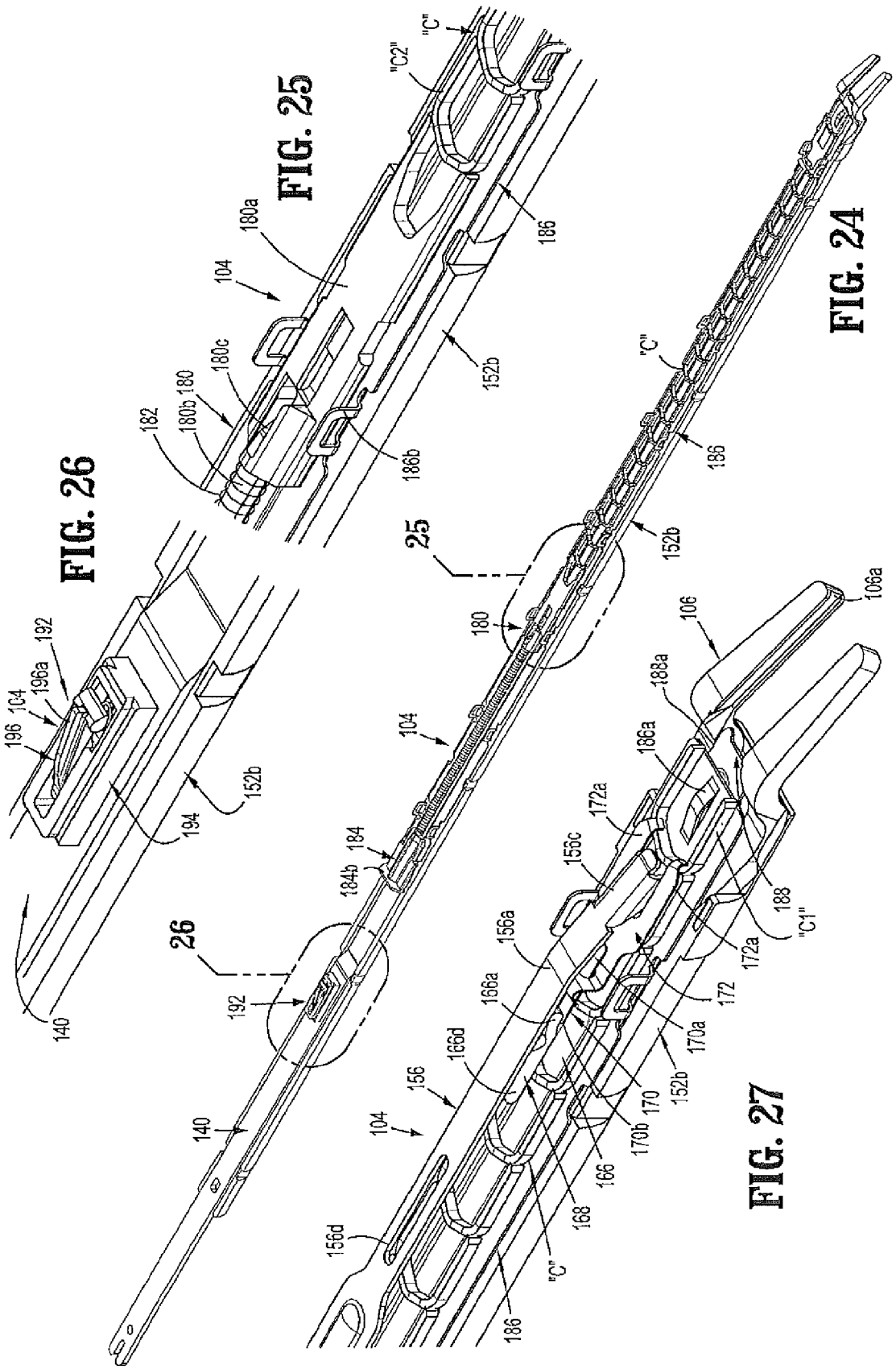
FIG. 24
FIG. 25
FIG. 26
FIG. 27
"C"
"C2"
"C1"
186
180a
104
180c
180b
180
182
186b
152b
25
26
106a
106
188a
186a
172a
156c
188
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156a
166a
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166d
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170b
166
168
156d
140
192
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184b
194
196
196a

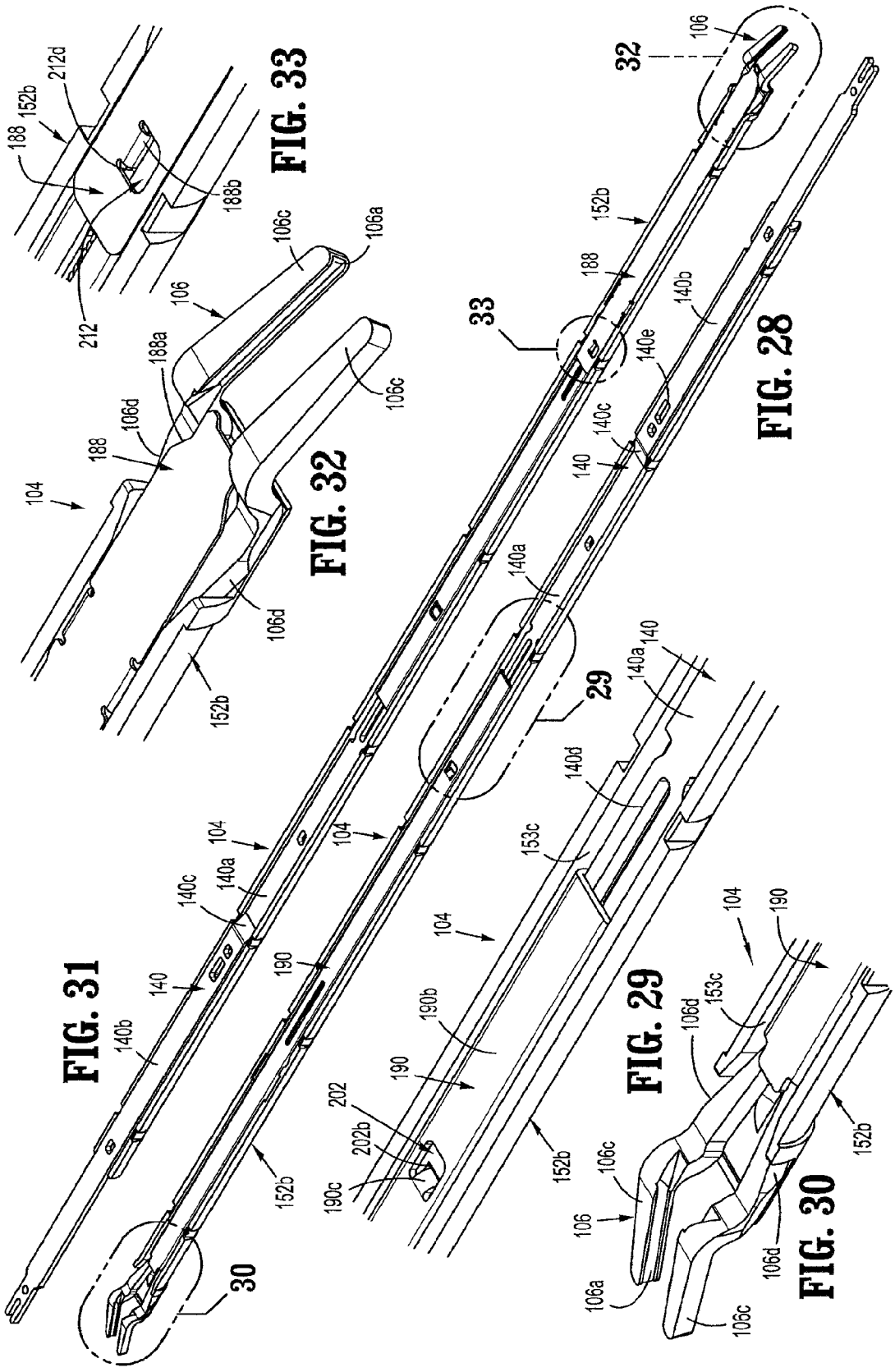
FIG. 31
FIG. 32
FIG. 33
FIG. 28
FIG. 29
FIG. 30
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140
140a
140b
140c
140d
140e
152b
153c
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188a
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106d
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32
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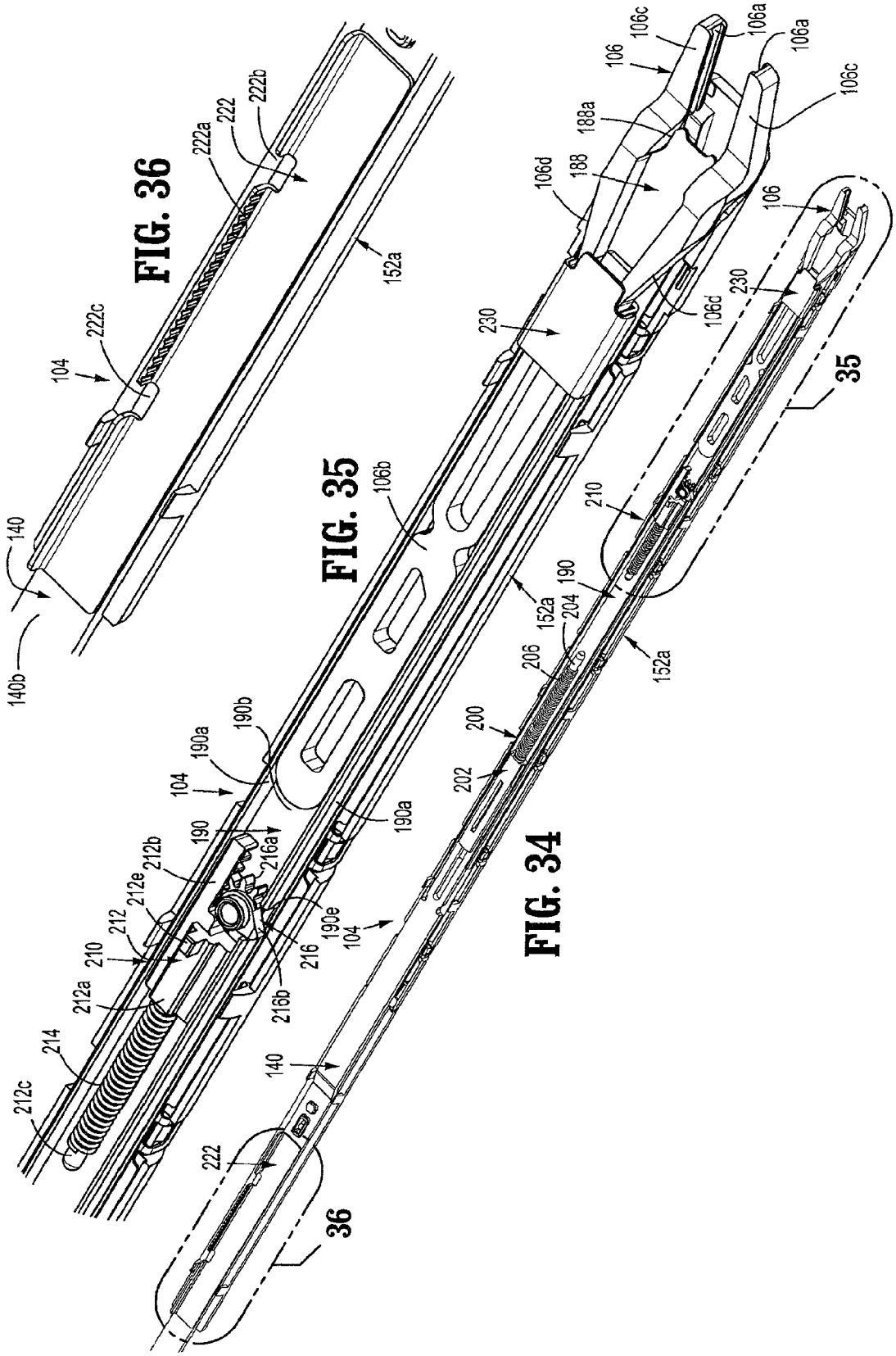
FIG. 36
FIG. 35
FIG. 34
222a
222
222b
222c
104
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140b
152a
106
106c
106a
188a
106d
188
230
35
210
190
204
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190b
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212c
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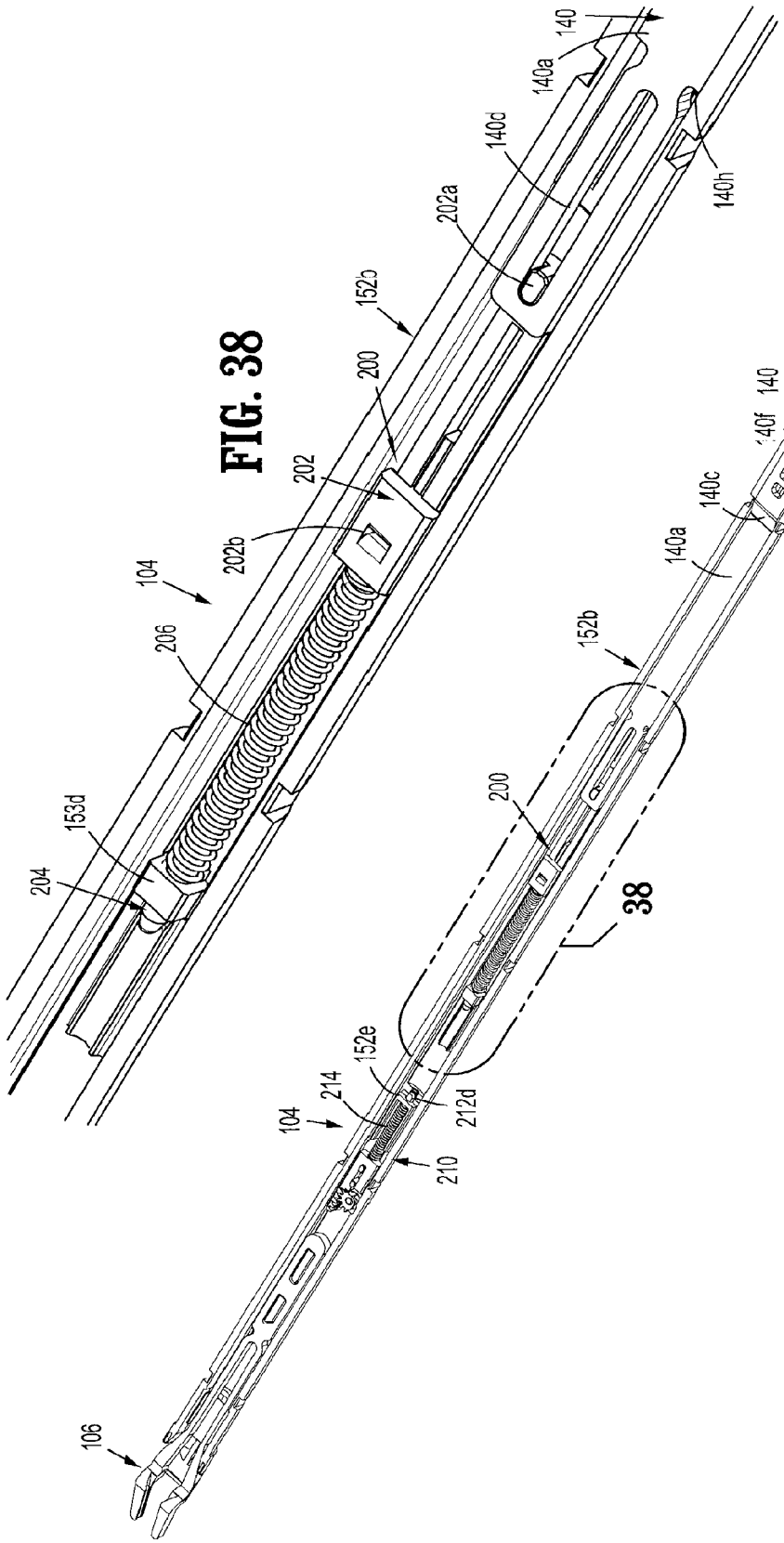
216b
190e
36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140a
140d
140h
202a
152b
200
202
202b
104
206
153d
204
106
214
152e
212d
210
38

FIG. 38

140b
140
140f
140c
140a
152b
200
38

FIG. 37

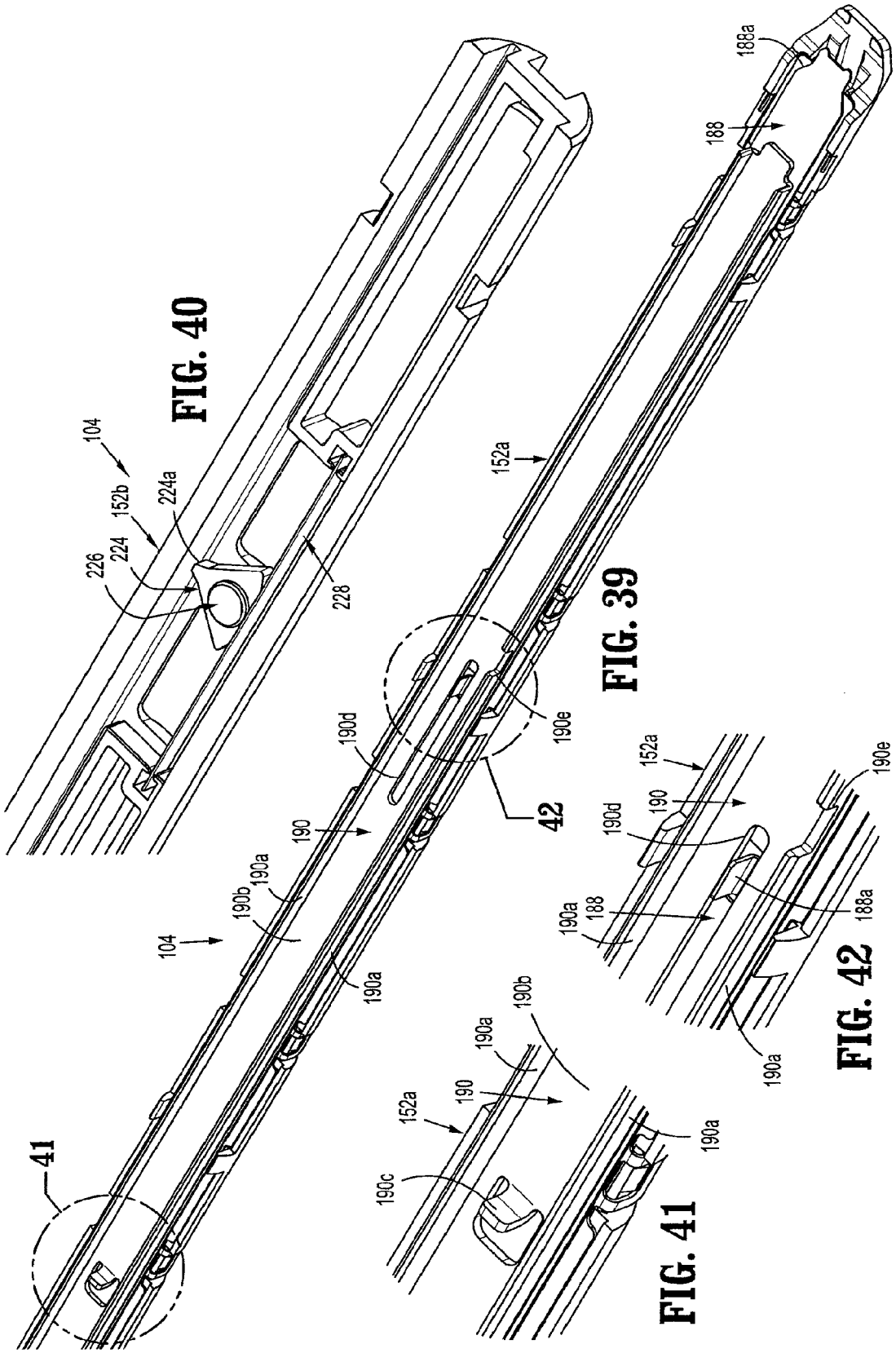


FIG. 40

FIG. 39

FIG. 42

FIG. 41

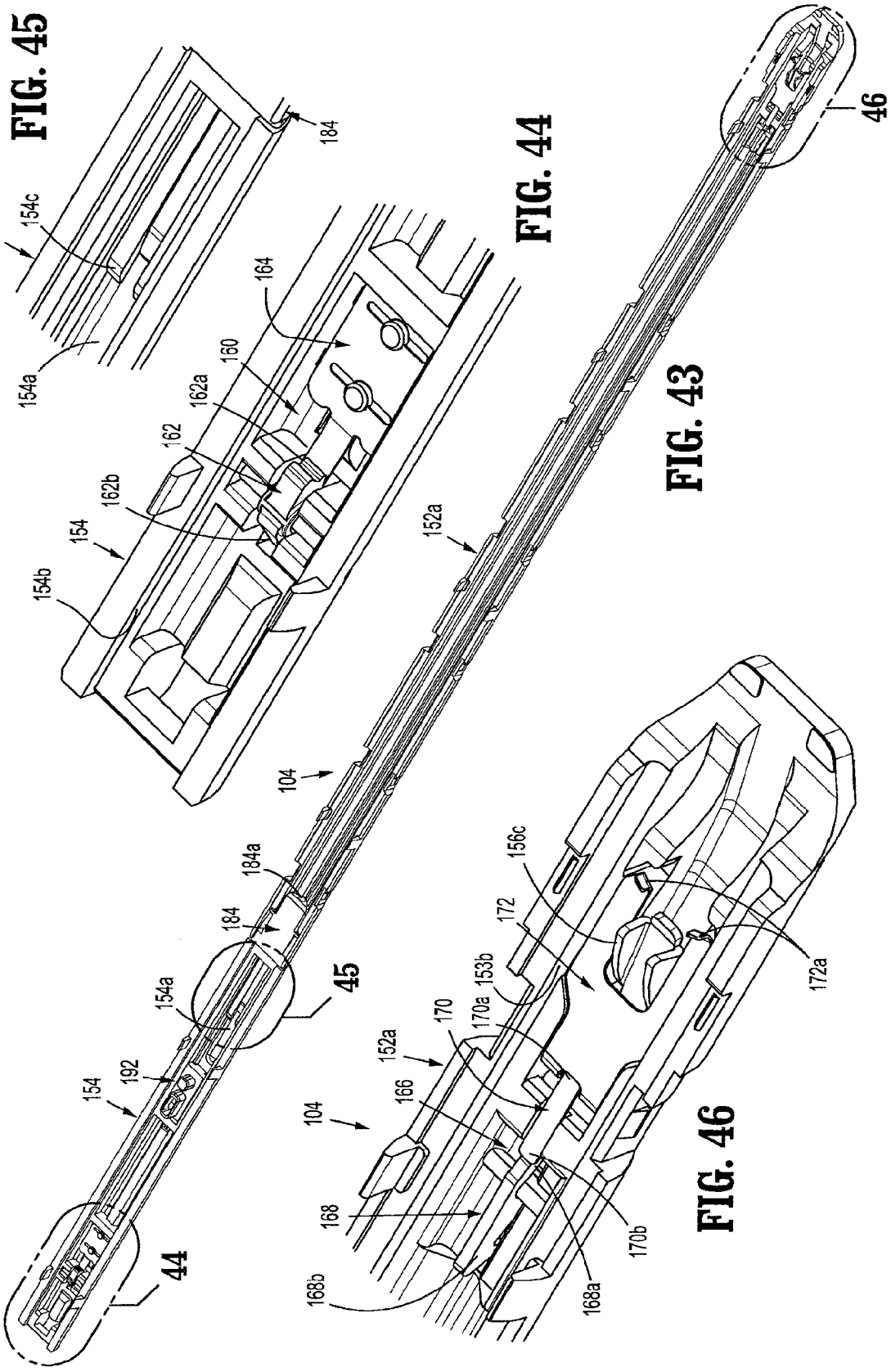
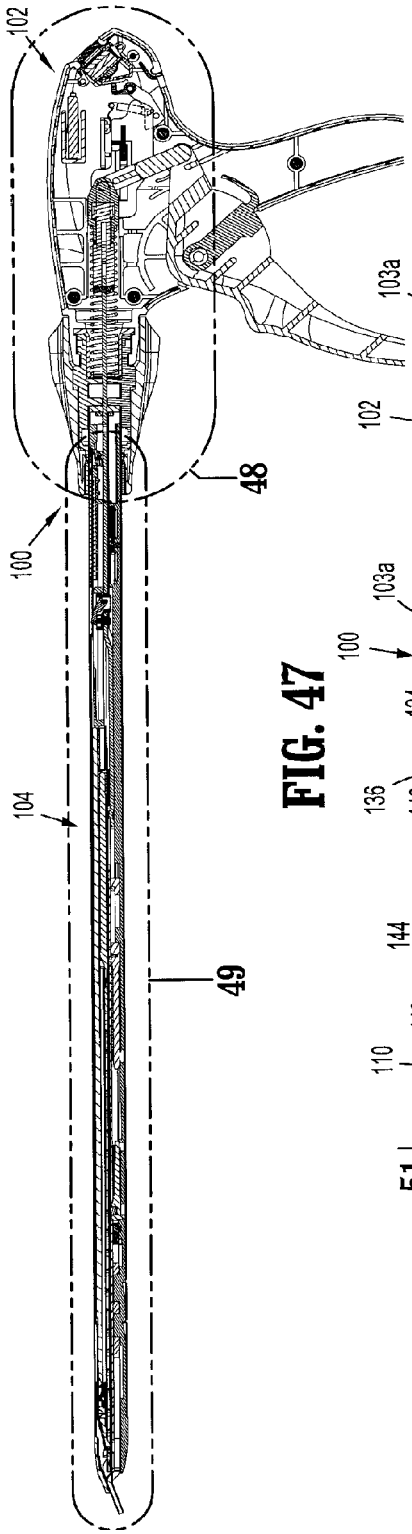


FIG. 45

FIG. 44

FIG. 43

FIG. 46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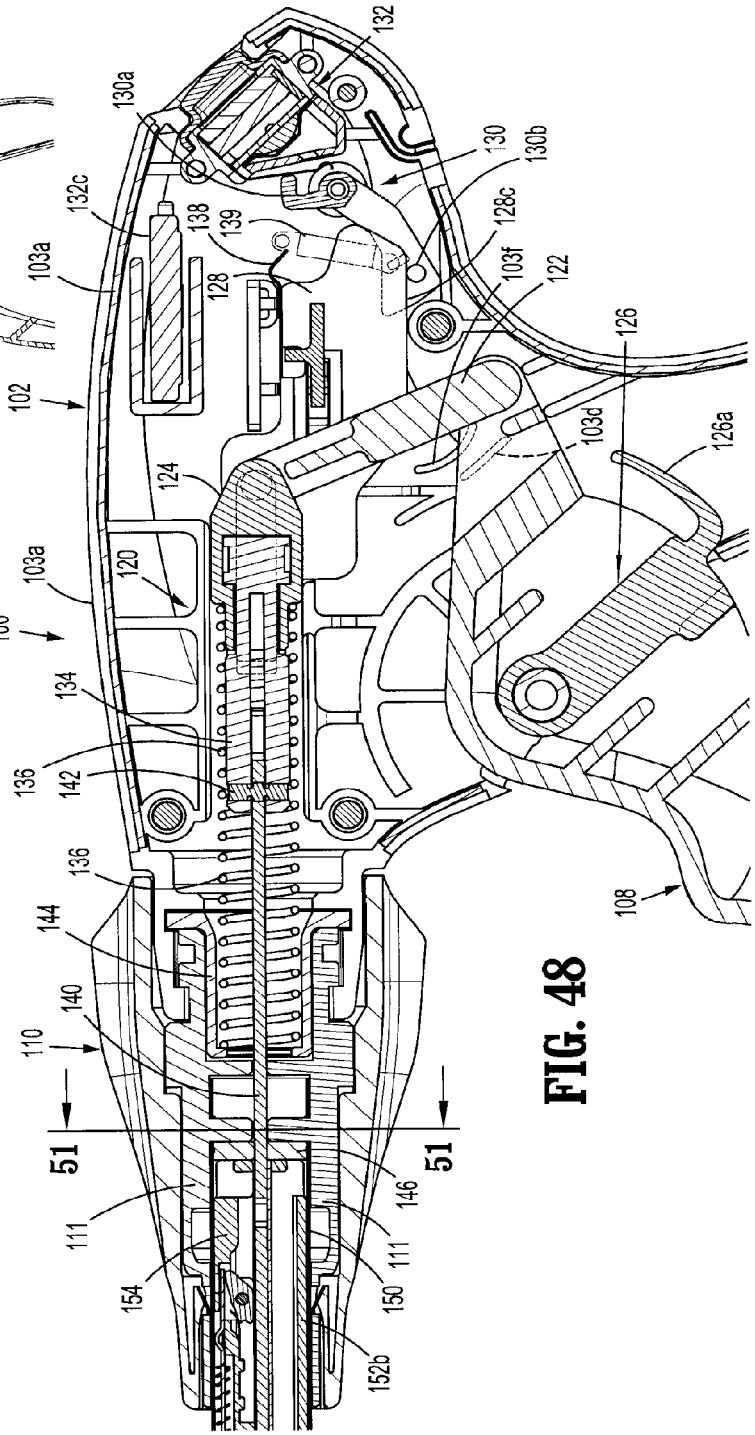
100
104
49

FIG. 47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130a
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130b
132c
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103a
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103f
122
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102
103d
126a
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120
103a
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136
144
108
140
110
51
51
146
111
111
154
150
152b

FIG. 48

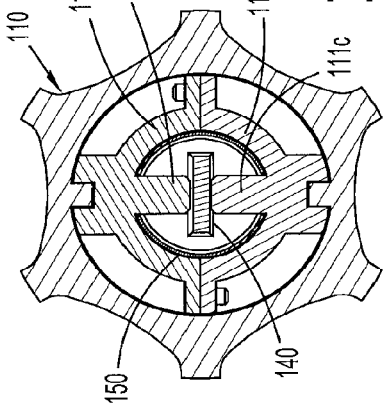


FIG. 51

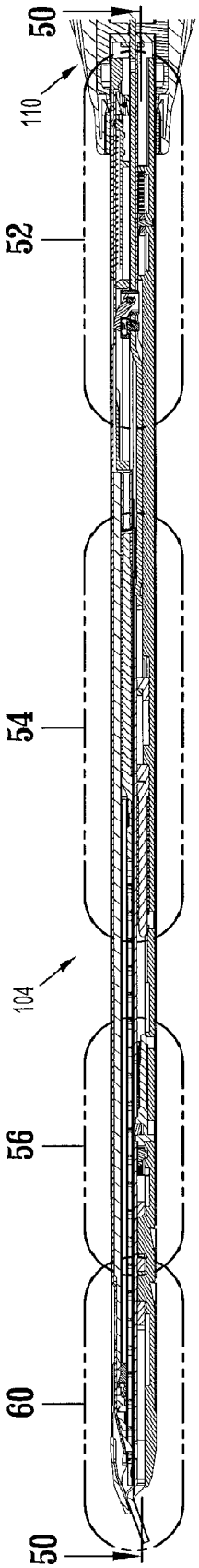


FIG. 49

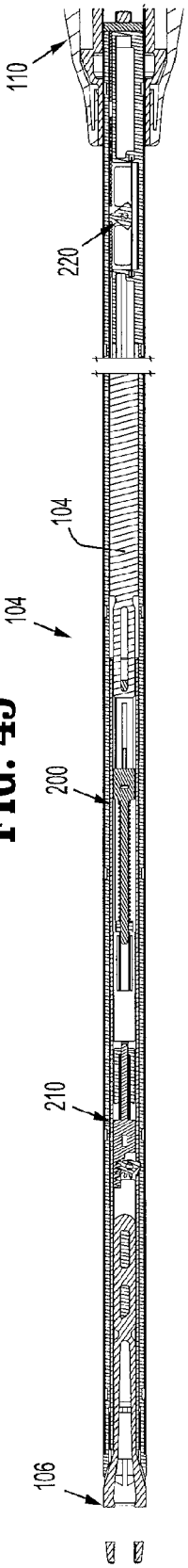
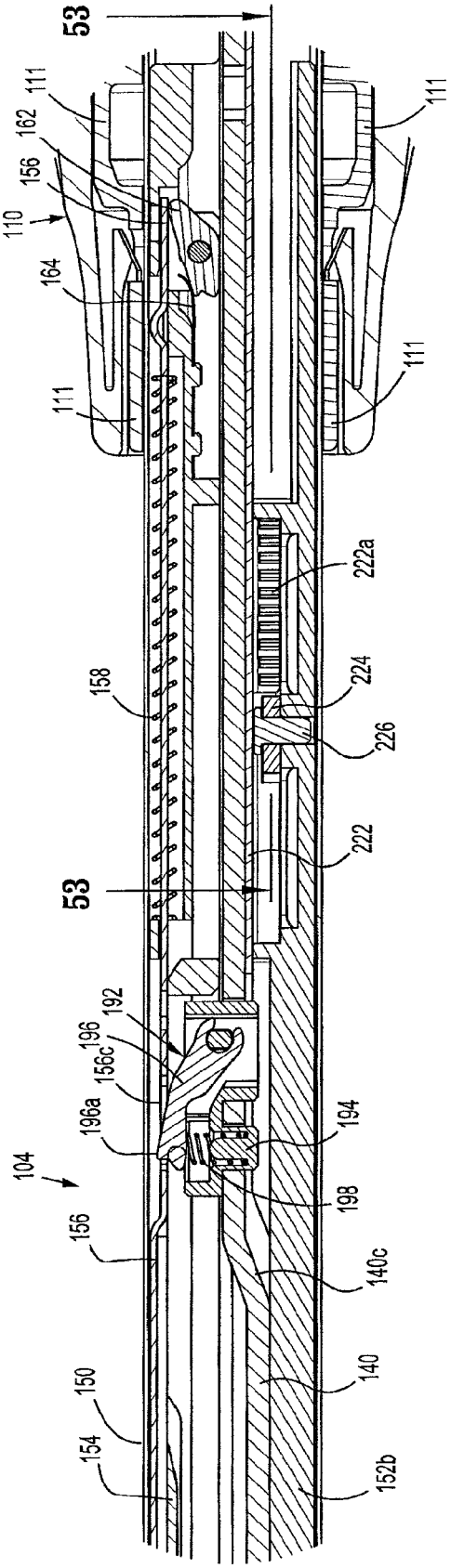


FIG. 50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222a
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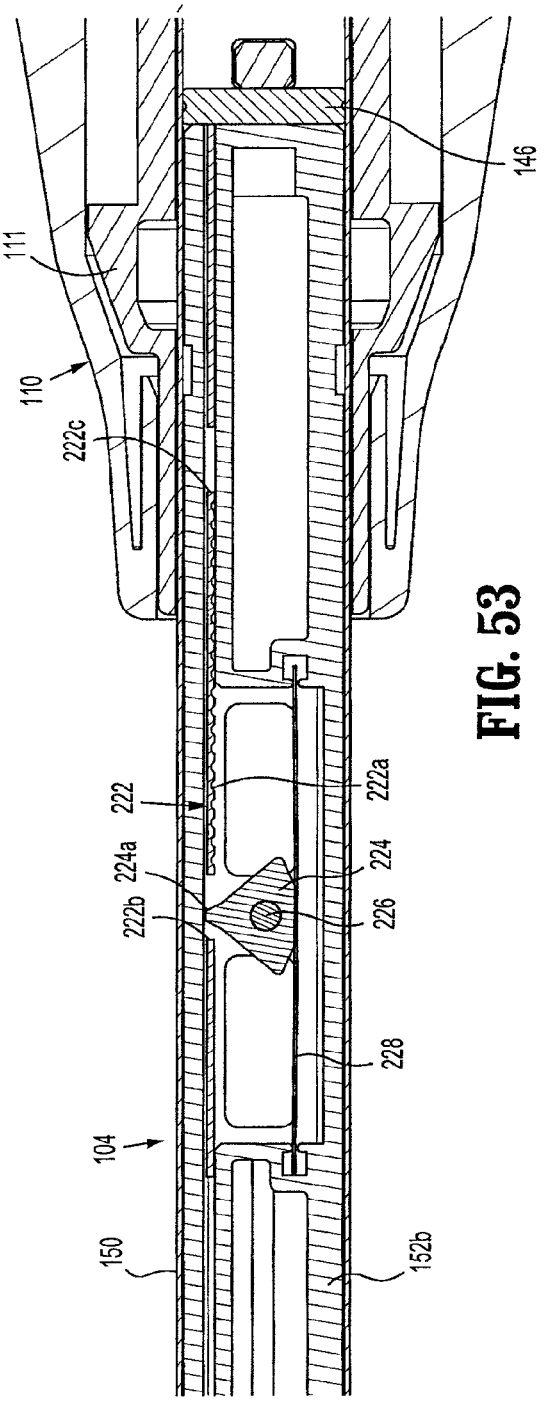
196
156c
196a
194
104
198
156
140c
140
150
154
152b

FIG. 52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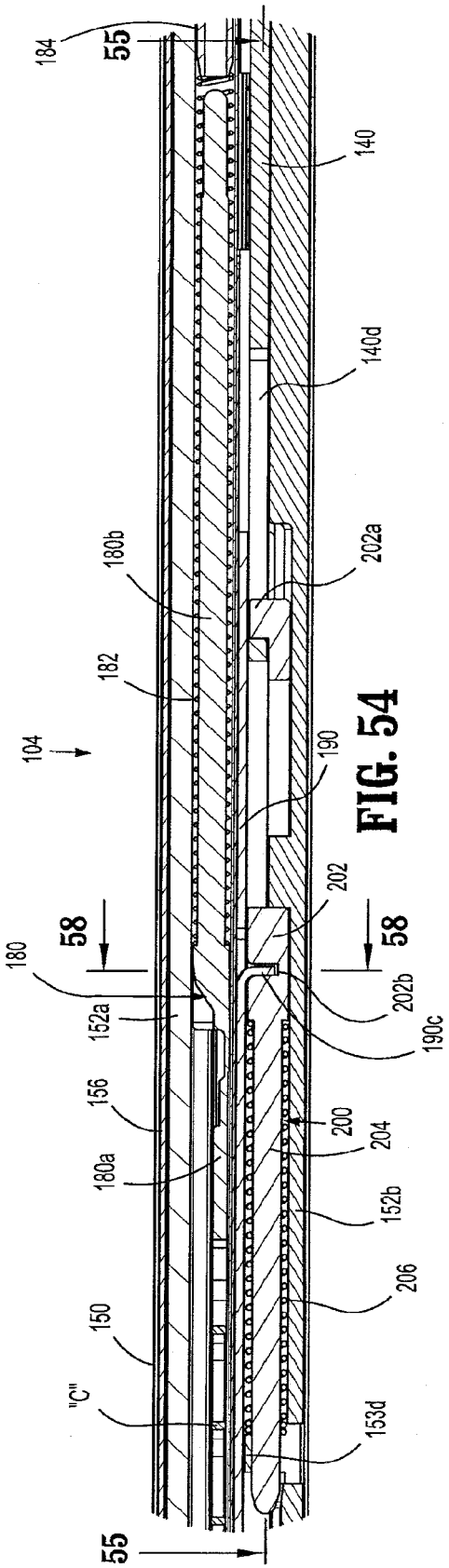
222
222a
224a
224
222b
226
228
104
150
152b

FIG. 53


184
55
140
140d
180b
202a
182
104
190
202
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58
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152a
202b
190c
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200
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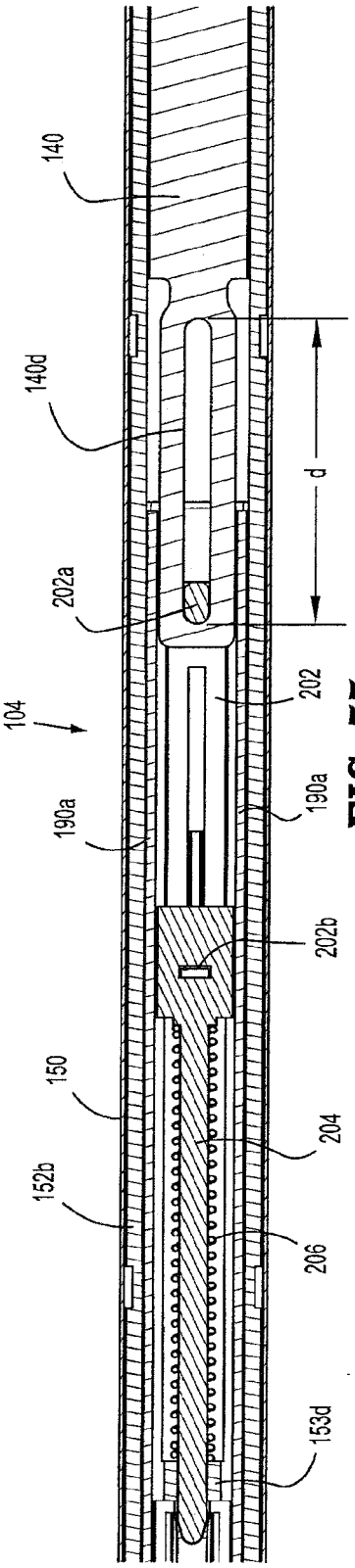
180a
152b
206
150
"C"
153d
55

FIG. 54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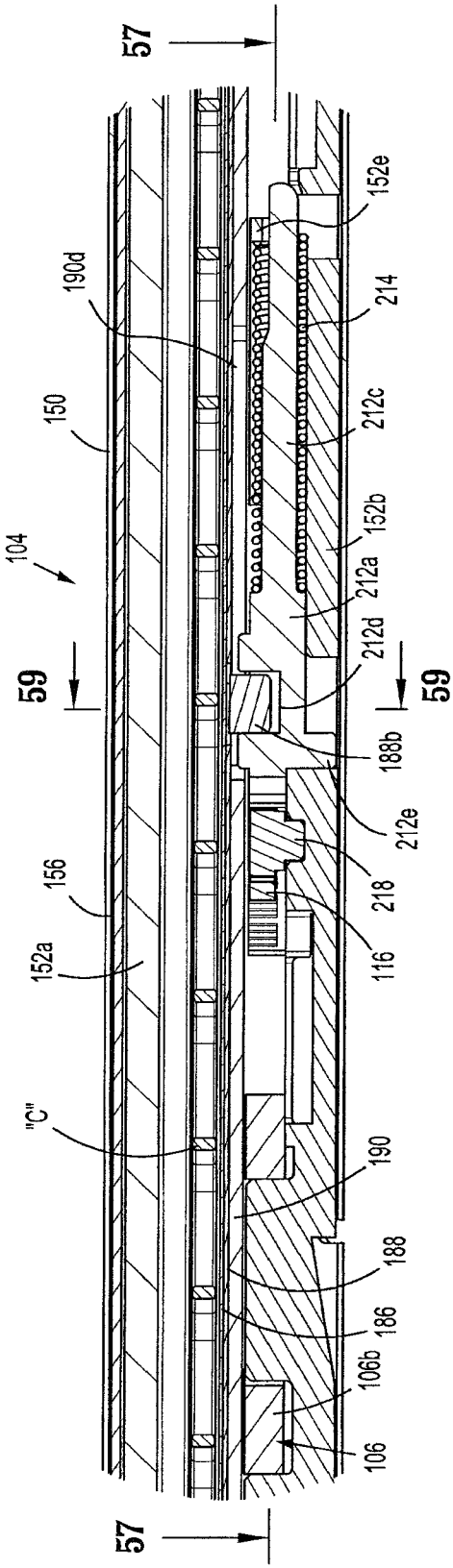
140d
d
202a
202
104
190a
190a
202b
150
204
152b
206
153d

FIG. 55


57
190d
150
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59
59
152e
214
212c
152b
212a
212d
188b
212e
218
116
156
152a
"C"
190
188
186
106b
106
57

FIG. 56

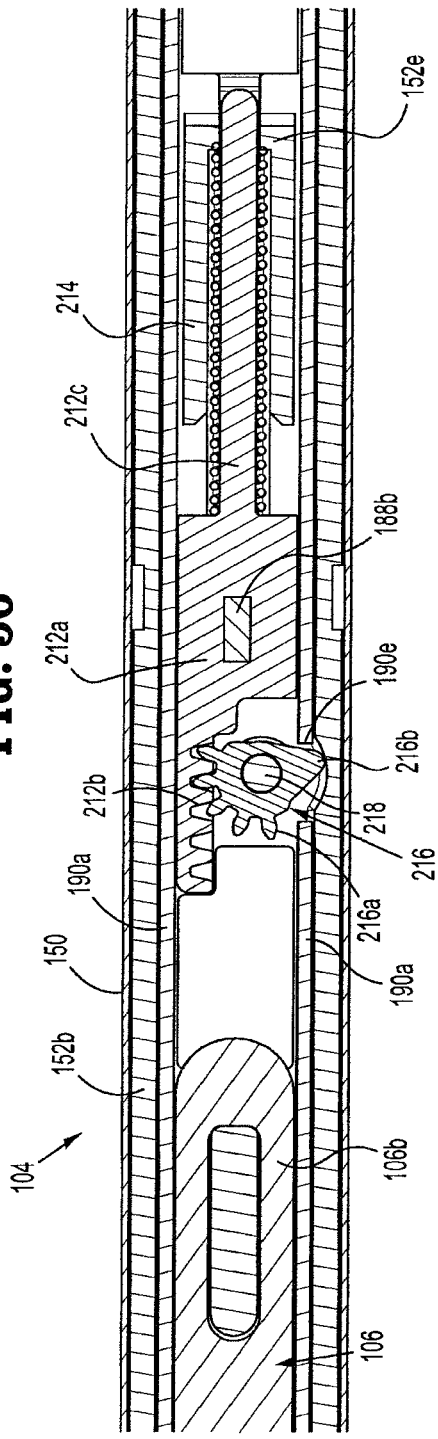
152e
214
212c
188b
212a
190e
216b
212b
218
216
190a
216a
150
190a
152b
104
106b
106

FIG. 57

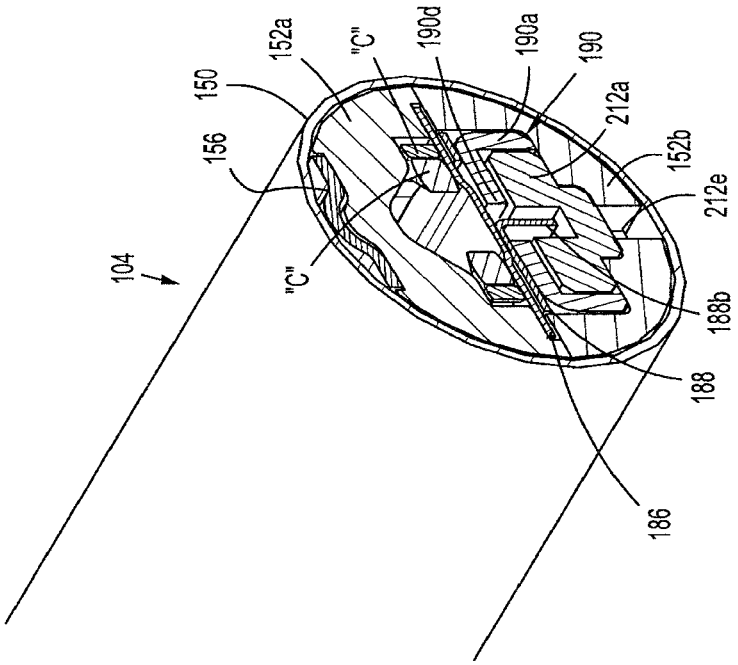
104
150
152a
"C"
190d
190a
190
212a
152b
212e
156
"C"
188b
188
186

FIG. 59

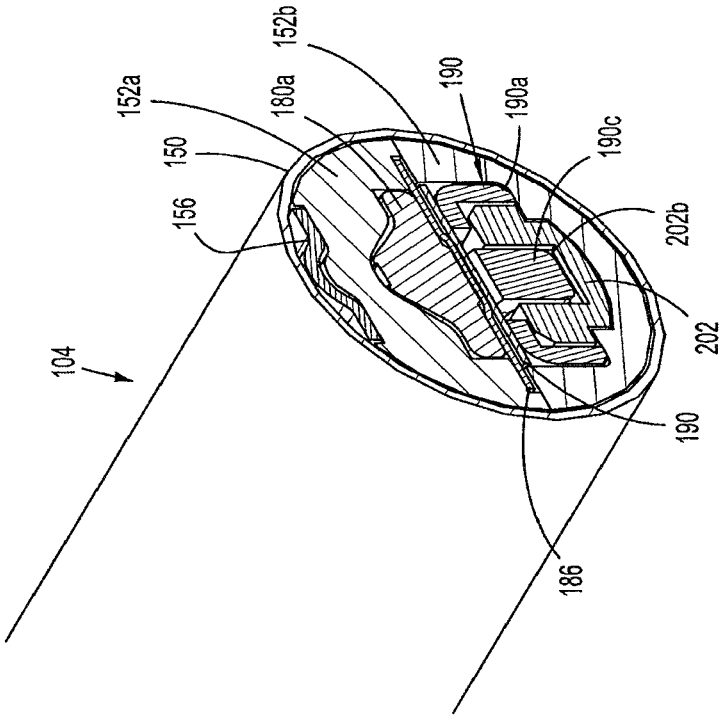
104
150
152a
180a
152b
190
190a
190c
156
202b
202
190
186

FIG. 58

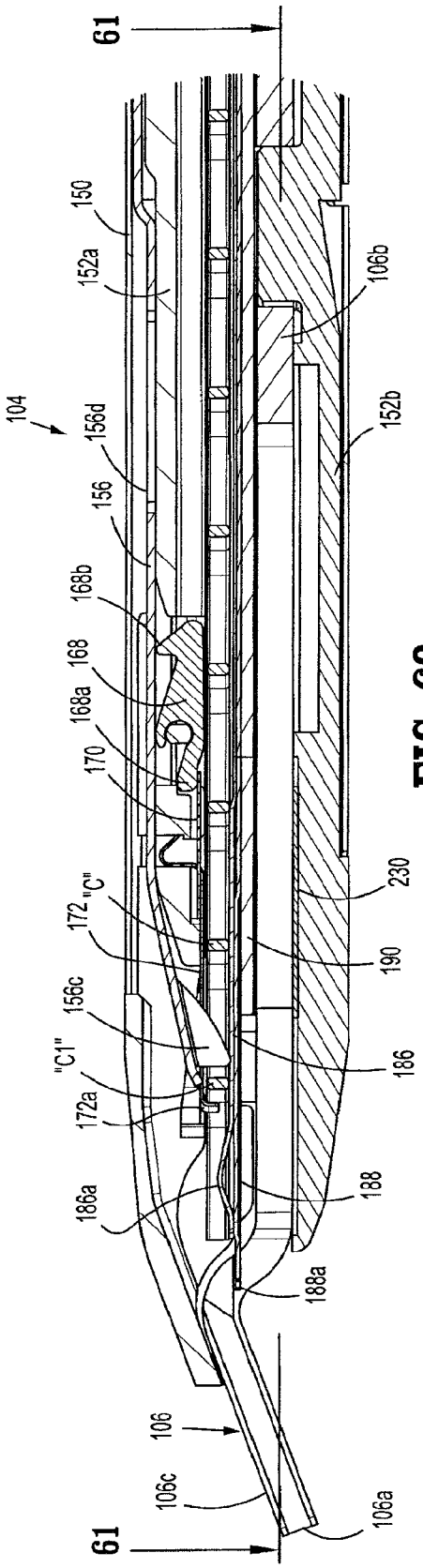
61
150
152a
106b
104
156d
152b
156
168b
168
168a
170
230
172
"C"
190
156c
186
"C1"
172a
188
186a
188a
106
106c
106a
61

FIG. 60

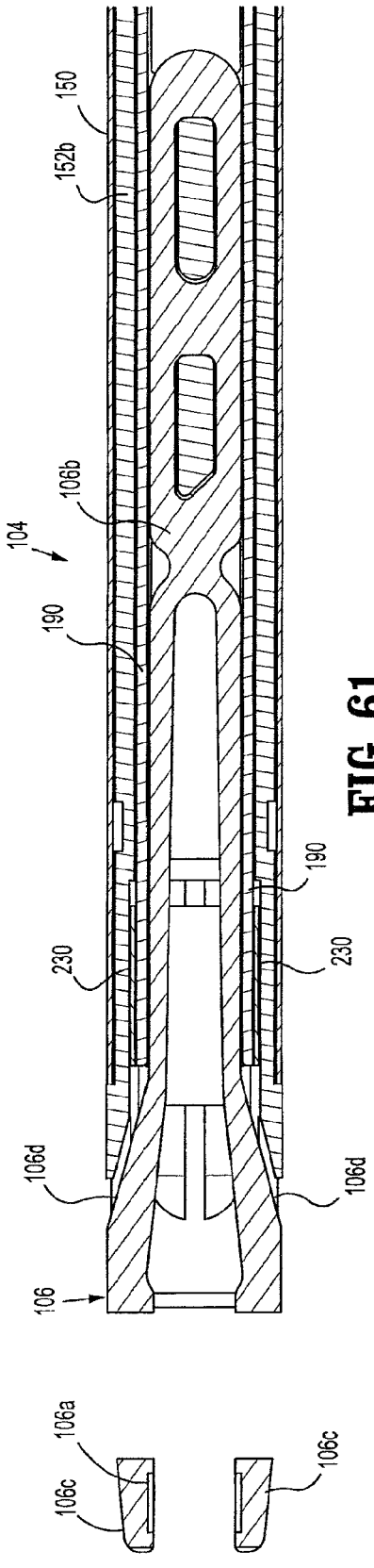
150
152b
106b
104
190
190
230
230
106d
106d
106
106a
106c
106c

FIG. 61

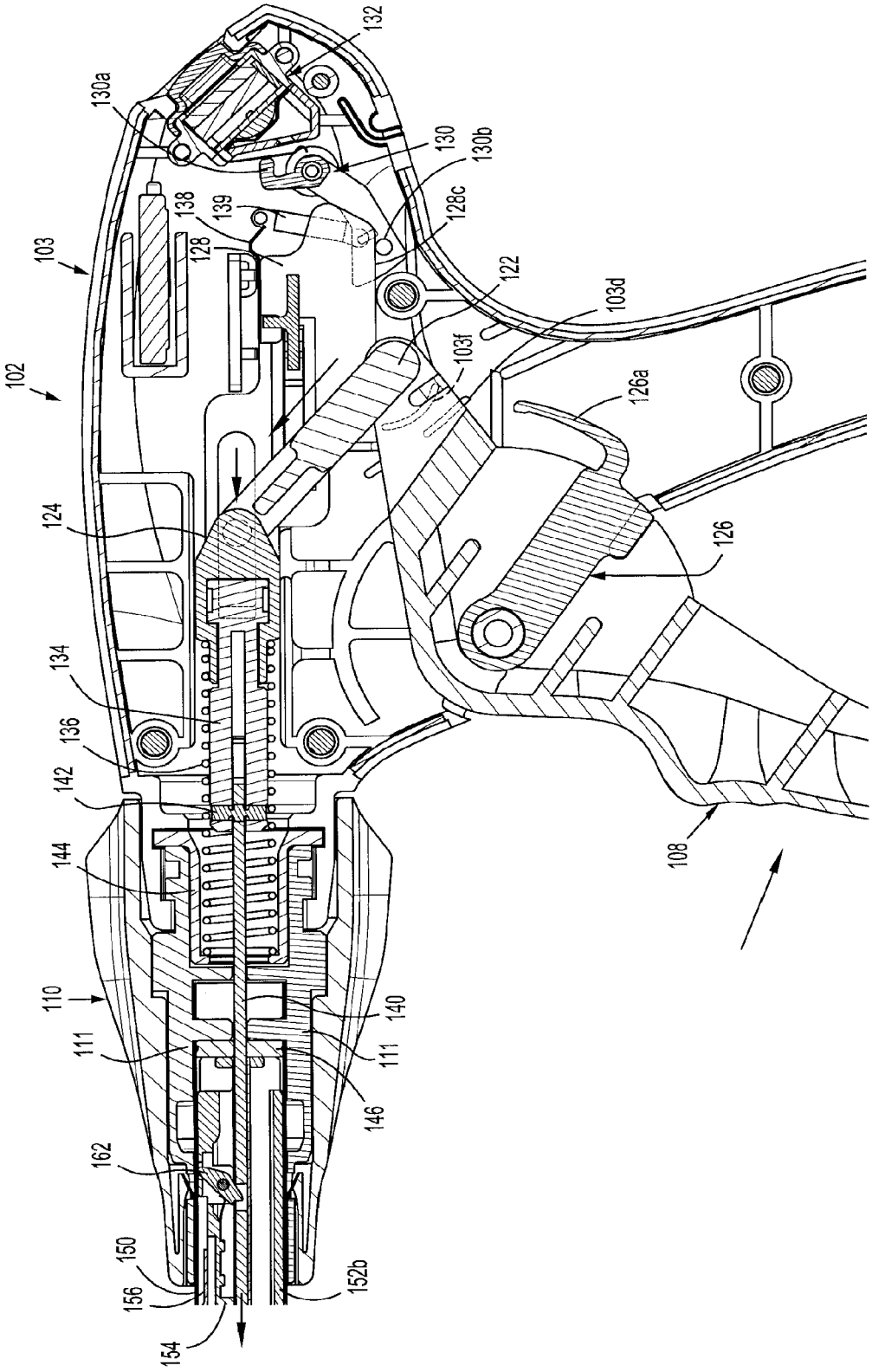
132
130a
130
130b
128c
138
139
128
103
122
103d
103f
102
126a
124
126
134
136
142
144
108
110
111
140
111
146
162
150
156
154
152b

FIG. 62

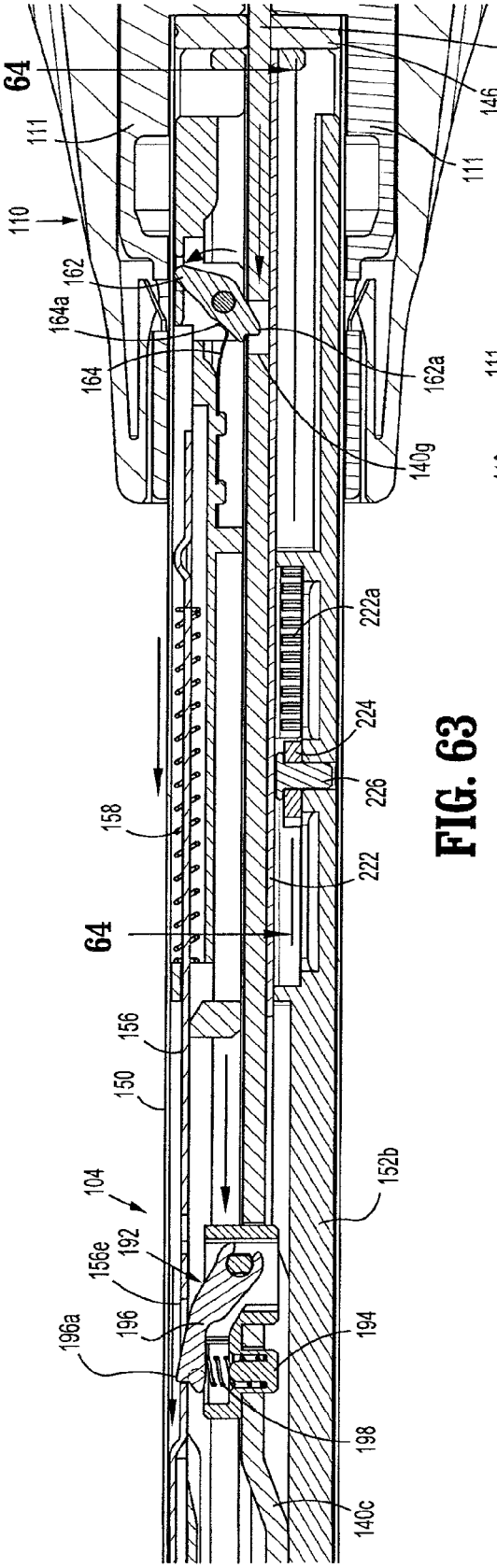
64
111
110
162
164a
164
140
146
111
162a
140g
222a
224
226
158
222
64
156
150
104
152b
192
156e
196
196a
194
198
140c

FIG. 63

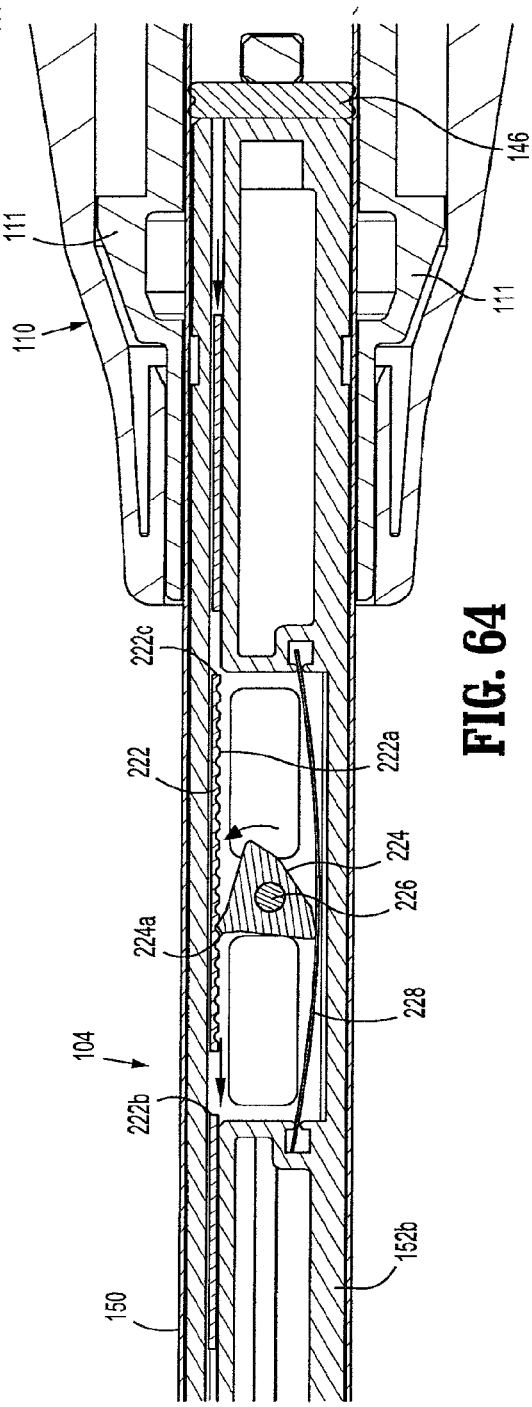
146
111
110
111
222c
222
222a
224
226
224a
228
104
222b
152b
150

FIG. 64

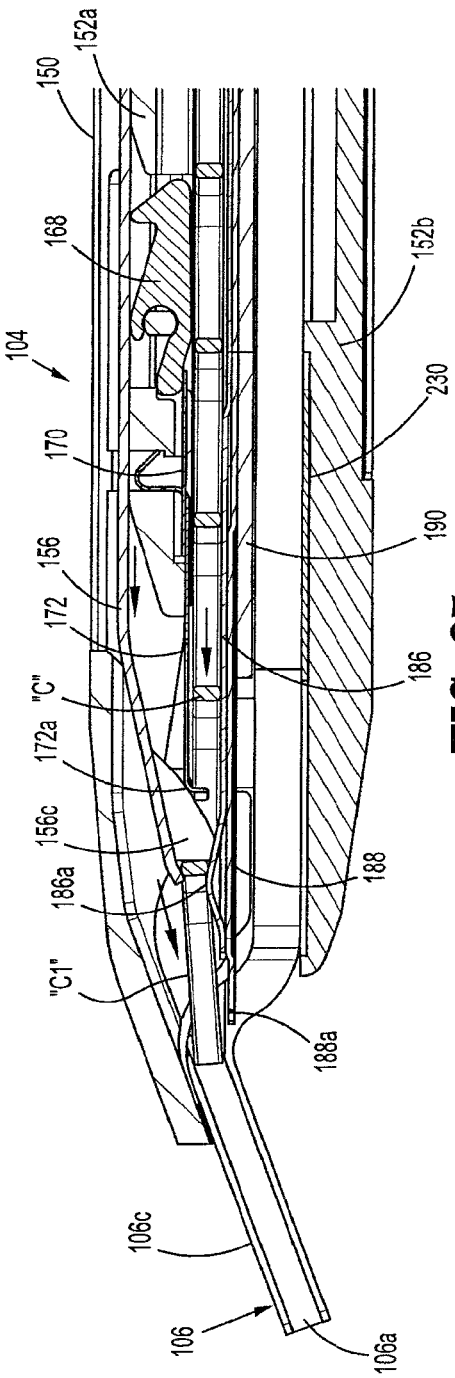
150
152a
168
104
170
156
172
"C"
172a
156c
186a
"C1"
152b
230
190
186
188
188a
106c
106
106a

FIG. 65

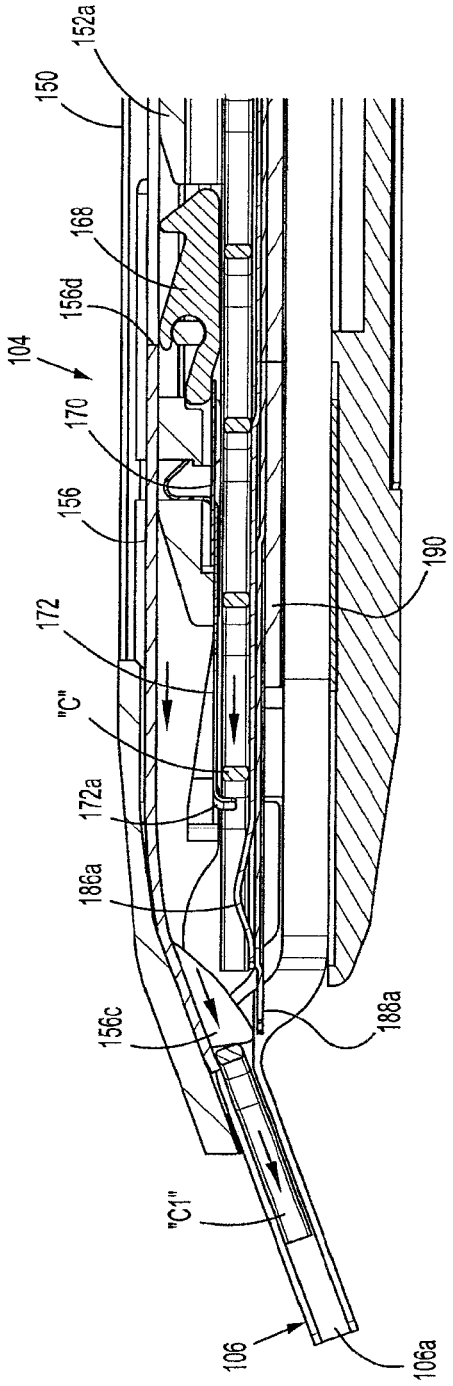
150
152a
168
156d
104
170
156
172
"C"
172a
186a
156c
"C1"
190
188a
106
106a

FIG. 66

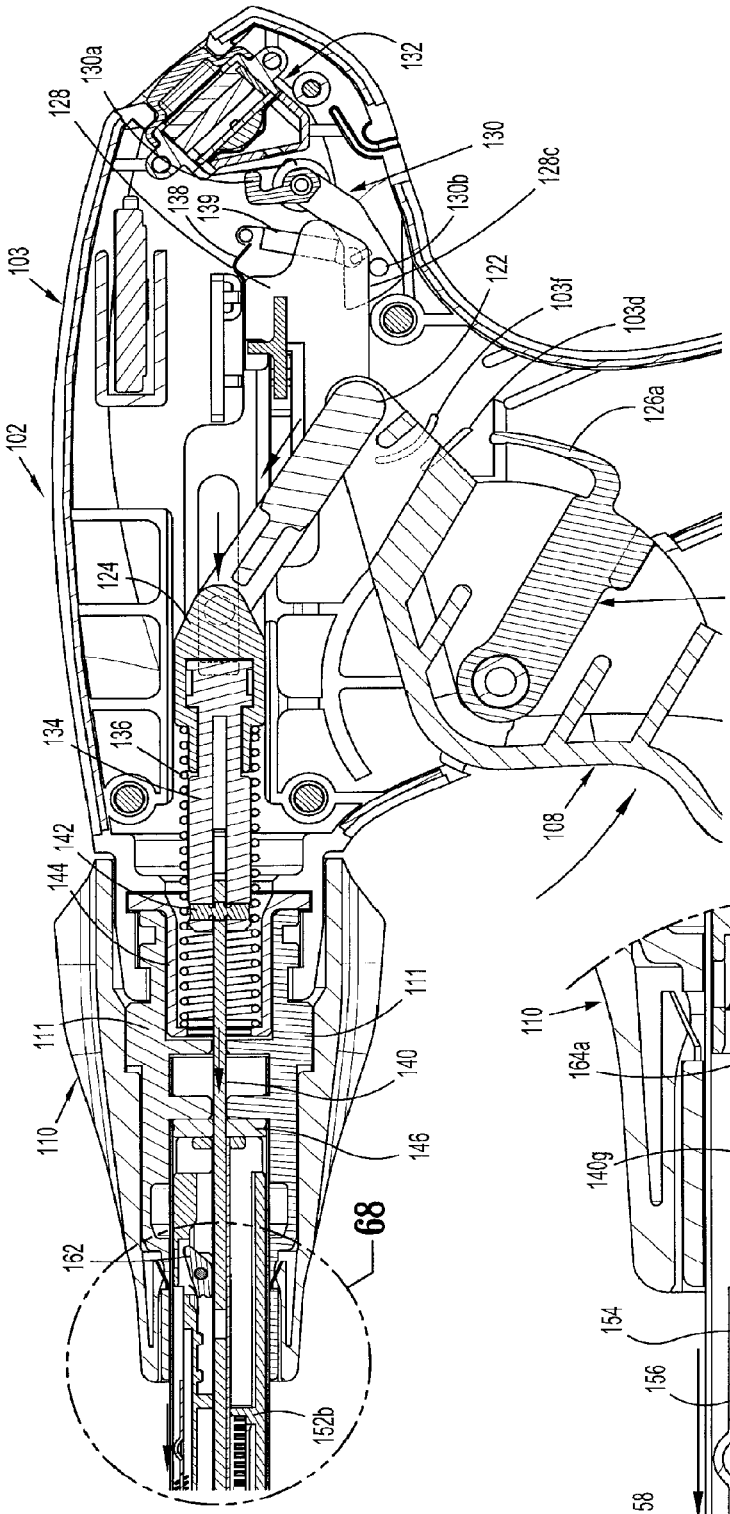
103
102
128
130a
132
130
128c
138
139
130b
122
103f
103d
126a
124
126
134
136
108
142
144
111
111
140
110
146
68
162
152b

FIG. 67

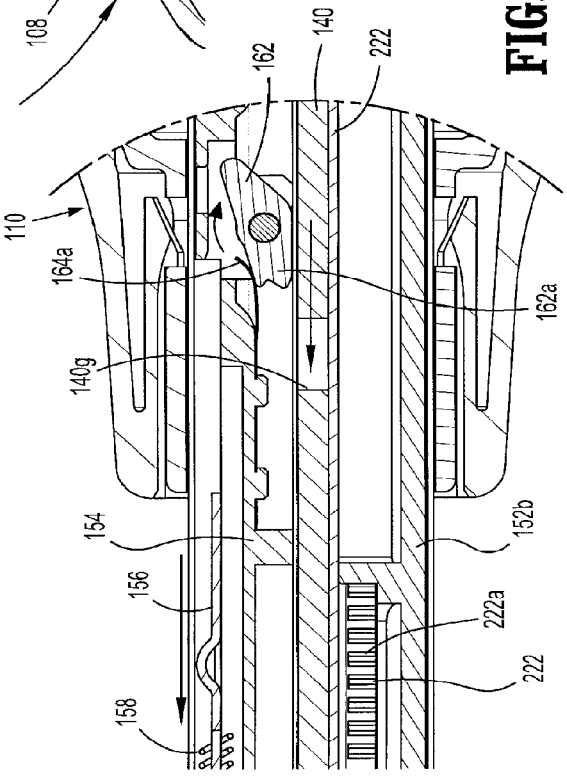
140
222
162
110
164a
162a
140g
154
152b
156
222a
222
158

FIG. 68

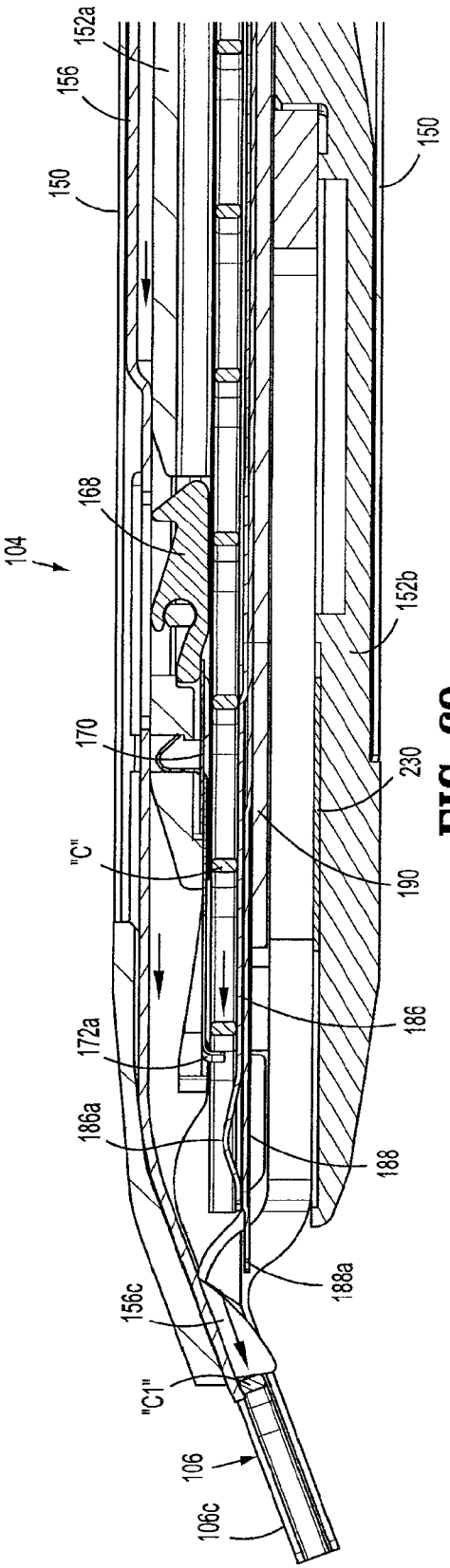
152a
156
150
150
168
104
170
"C"
172a
186a
156c
"C1"
106
106c
150
152b
230
190
186
188
188a

FIG. 69

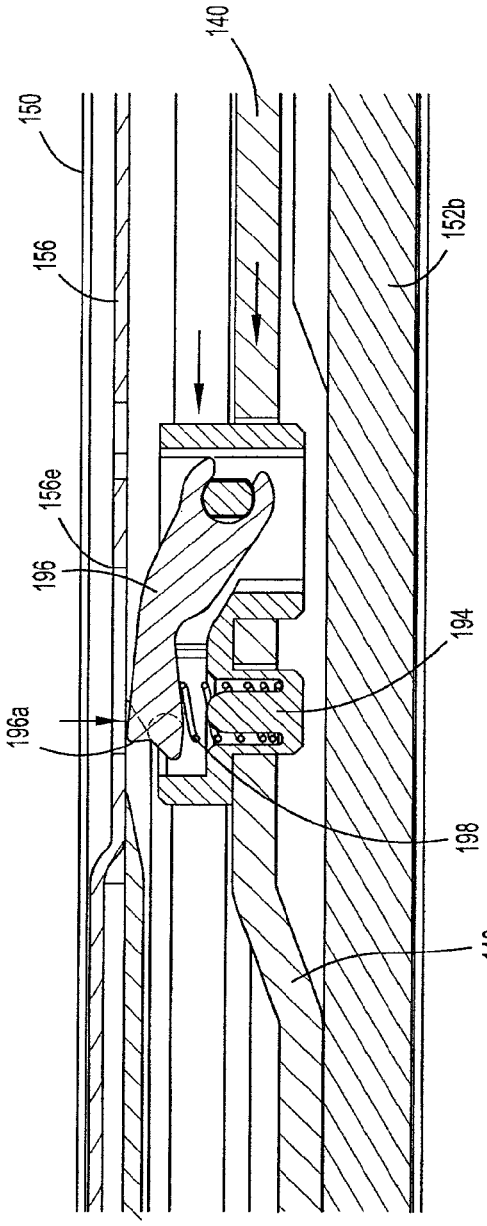
140
150
156
152b
156e
196
196a
194
198
140c

FIG. 70

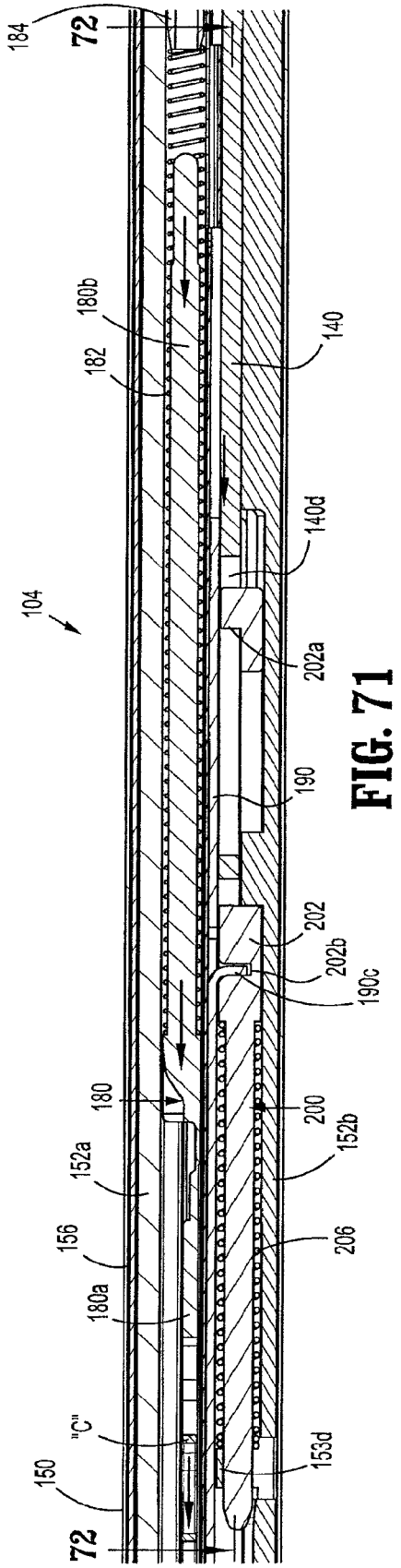
184
72
180b
182
140
140d
104
202a
190
202
202b
190c
180
200
152b
152a
156
206
180a
"C"
150
153d
72

FIG. 71

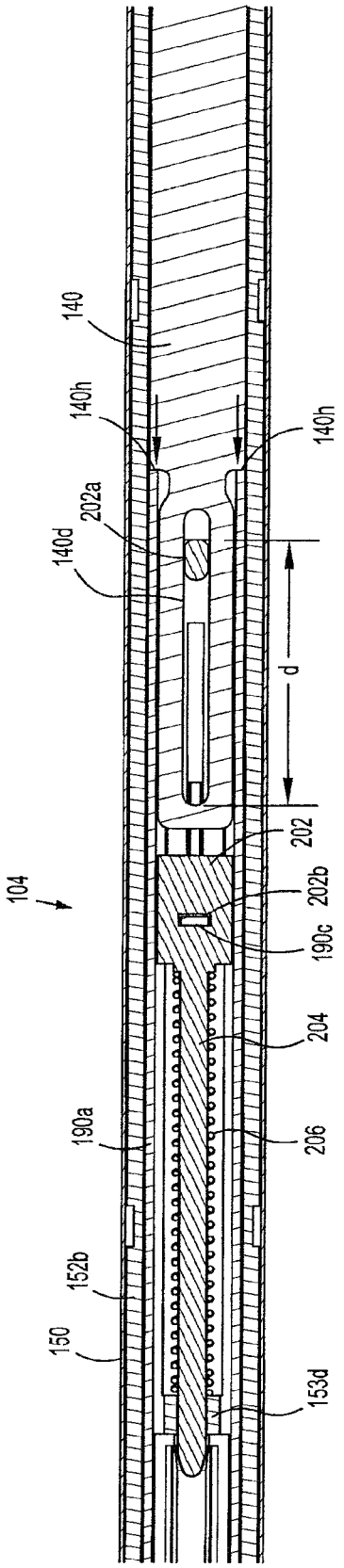
140
140h
140h
202a
140d
d
202
202b
104
190c
204
206
190a
152b
150
153d

FIG. 72

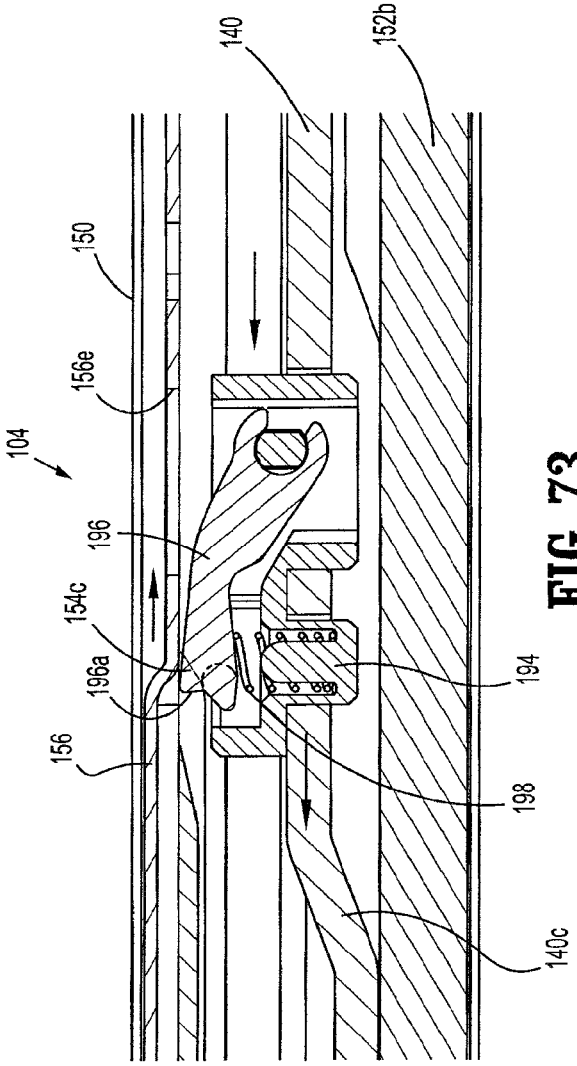
140
152b
150
156e
104
196
154c
196a
194
156
198
140c

FIG. 73

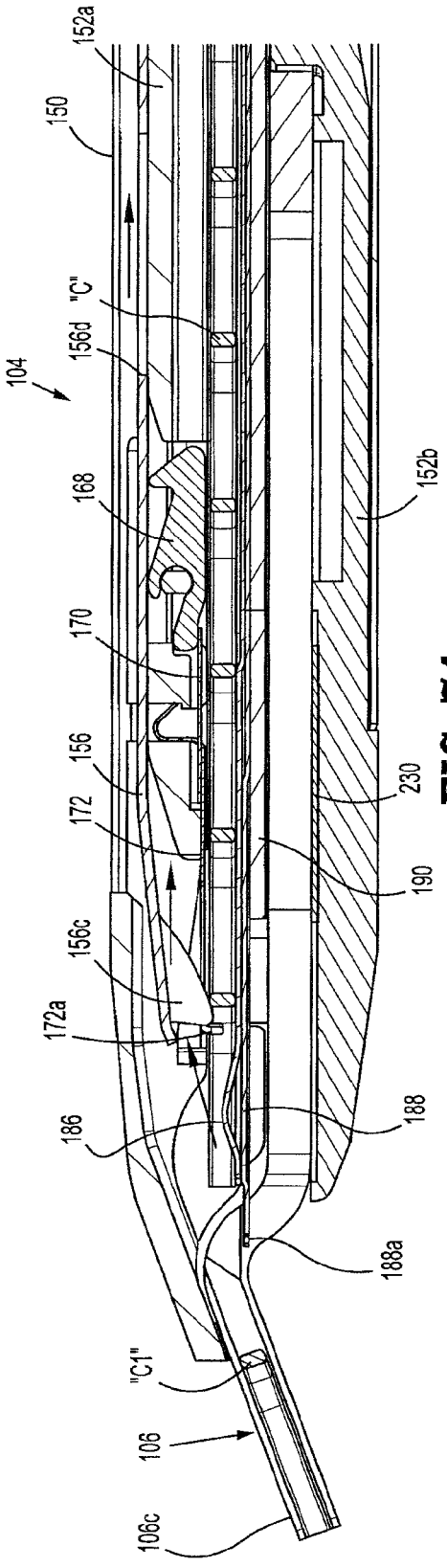
152a
150
"C"
156d
104
168
152b
170
156
230
172
190
156c
172a
186
188
188a
"C1"
106
106c

FIG. 74

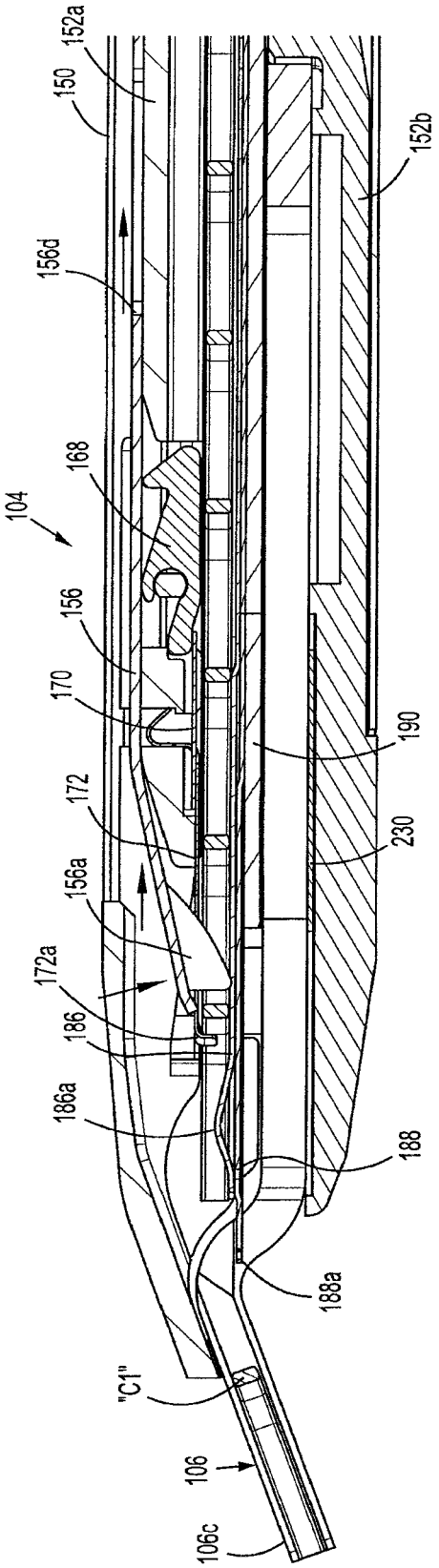
152a
150
152b
156d
168
104
156
170
190
172
230
156a
172a
186
186a
188
188a
"C1"
106
106c

FIG. 75

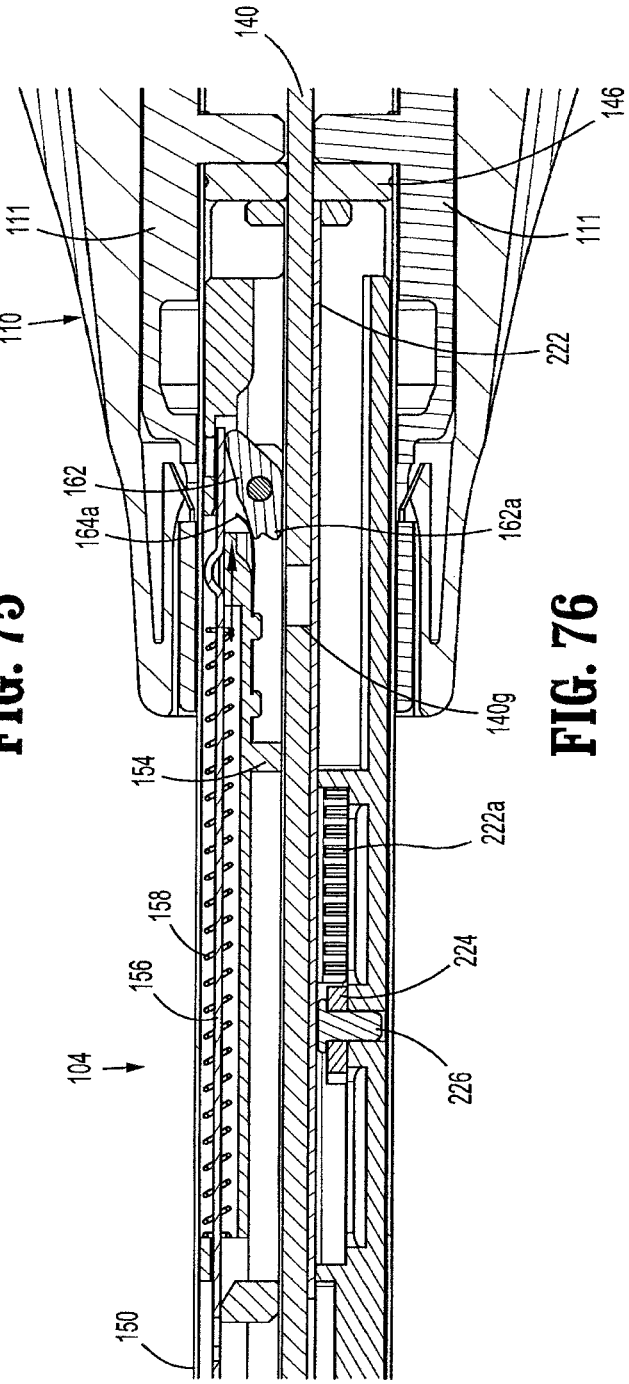
140
146
111
111
110
222
162
164a
162a
140g
154
222a
158
224
156
104
226
150

FIG. 76

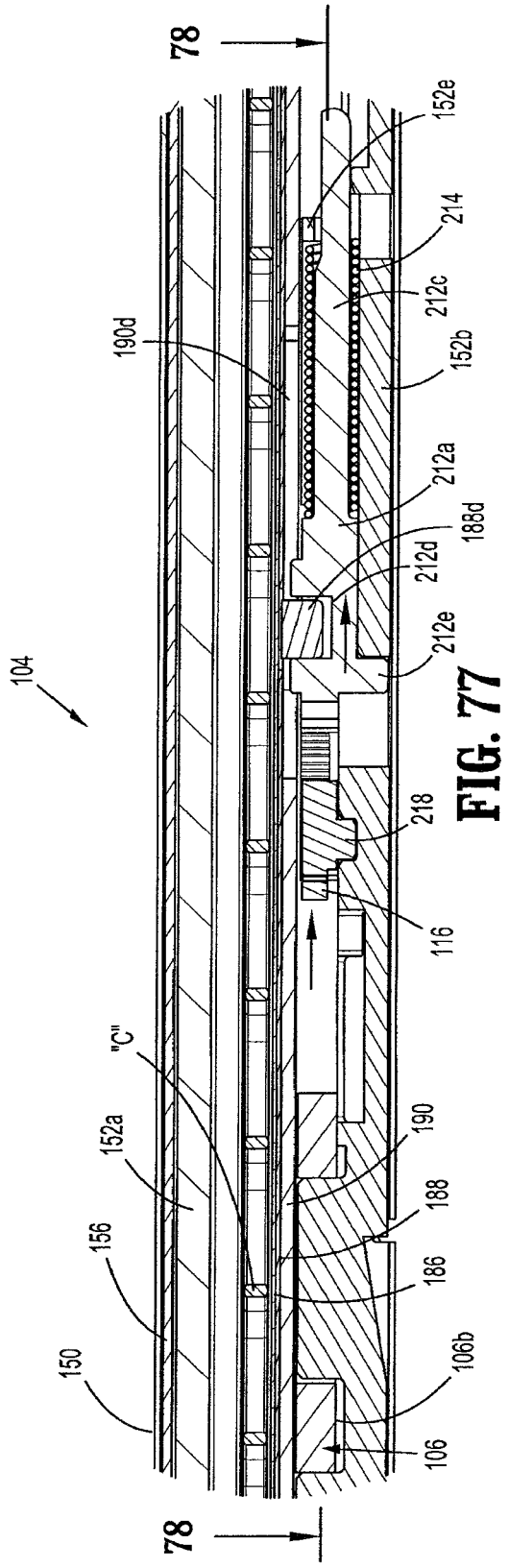
78
152e
214
212c
190d
152b
212a
188d
212d
212e
104
218
116
"C"
152a
190
188
156
186
150
106b
106
78

FIG. 77

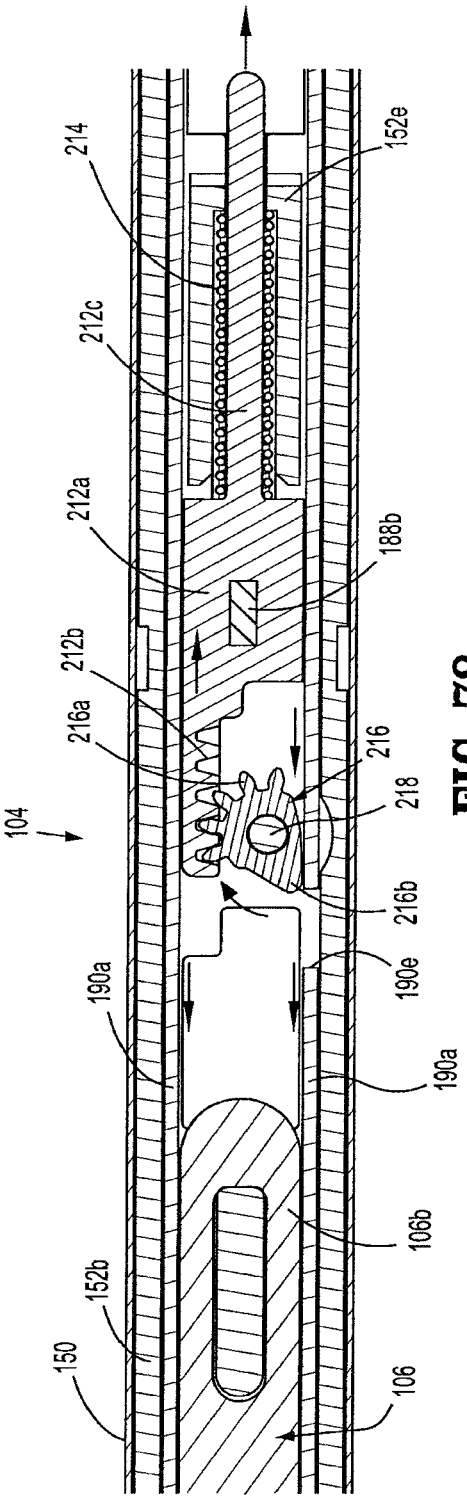
214
152e
212c
212a
188b
212b
216a
216
218
104
216b
190e
190a
190a
106b
152b
150
106

FIG. 78

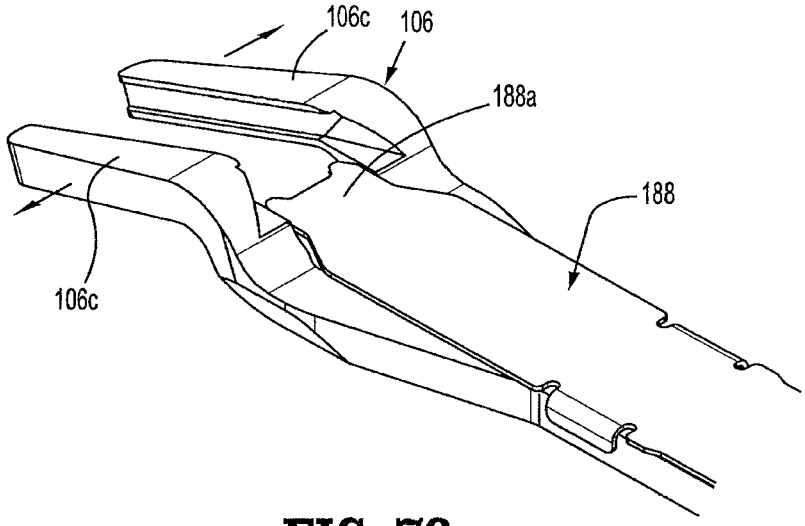

FIG. 79

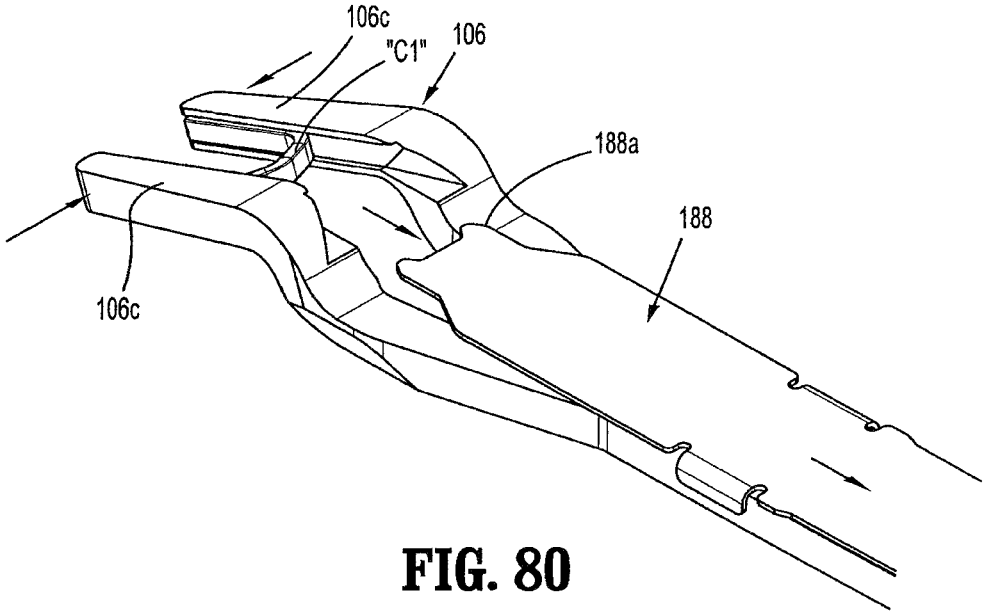

FIG. 80

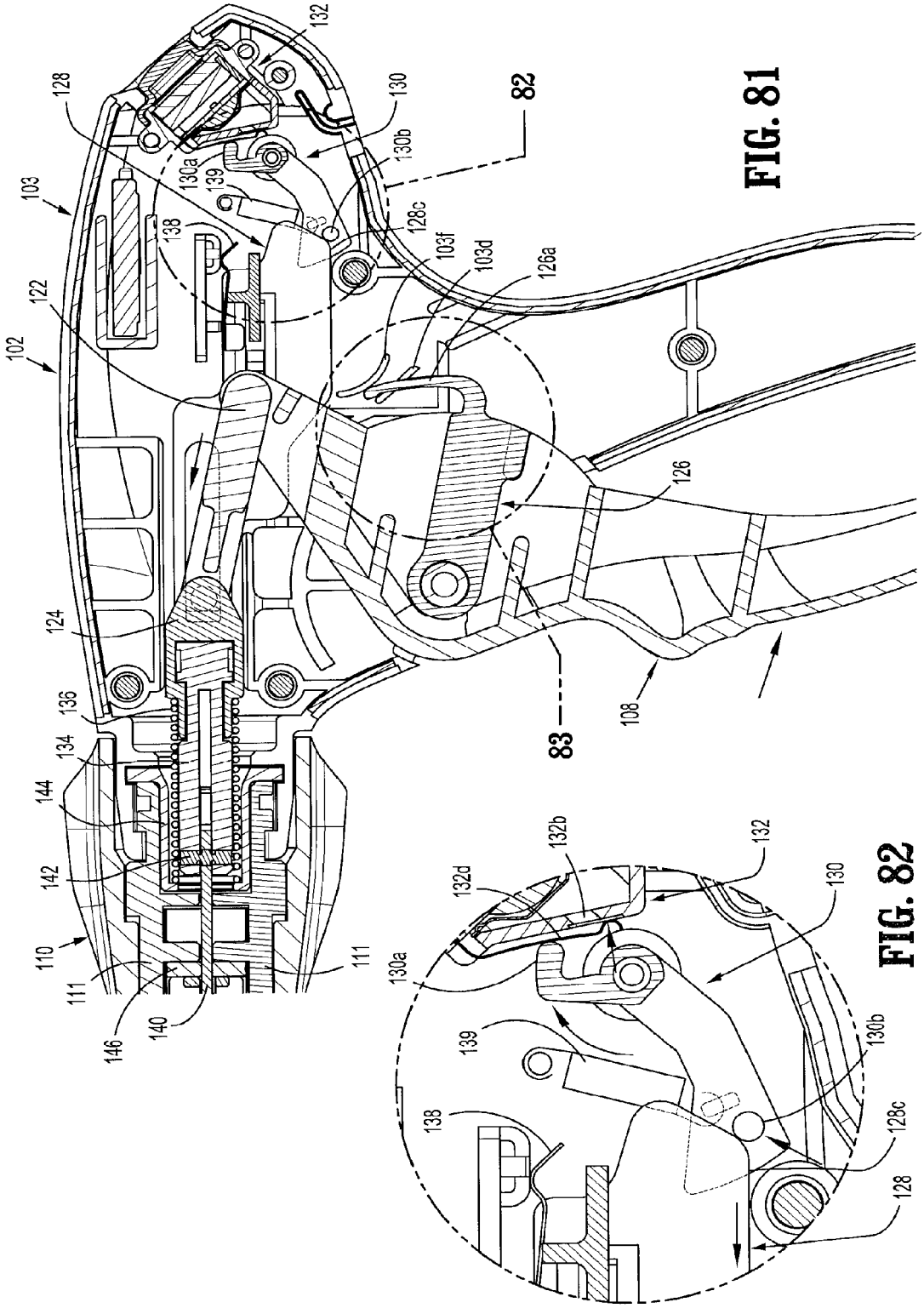
132
128
130
82
130a
139
130b
103
128c
138
103f
103d
126a
122
102
126
124
108
83
136
134
144
142
110
111
111
146
140
111
132b
132d
132
130
130a
139
130b
138
128c
128

FIG. 81

FIG. 82

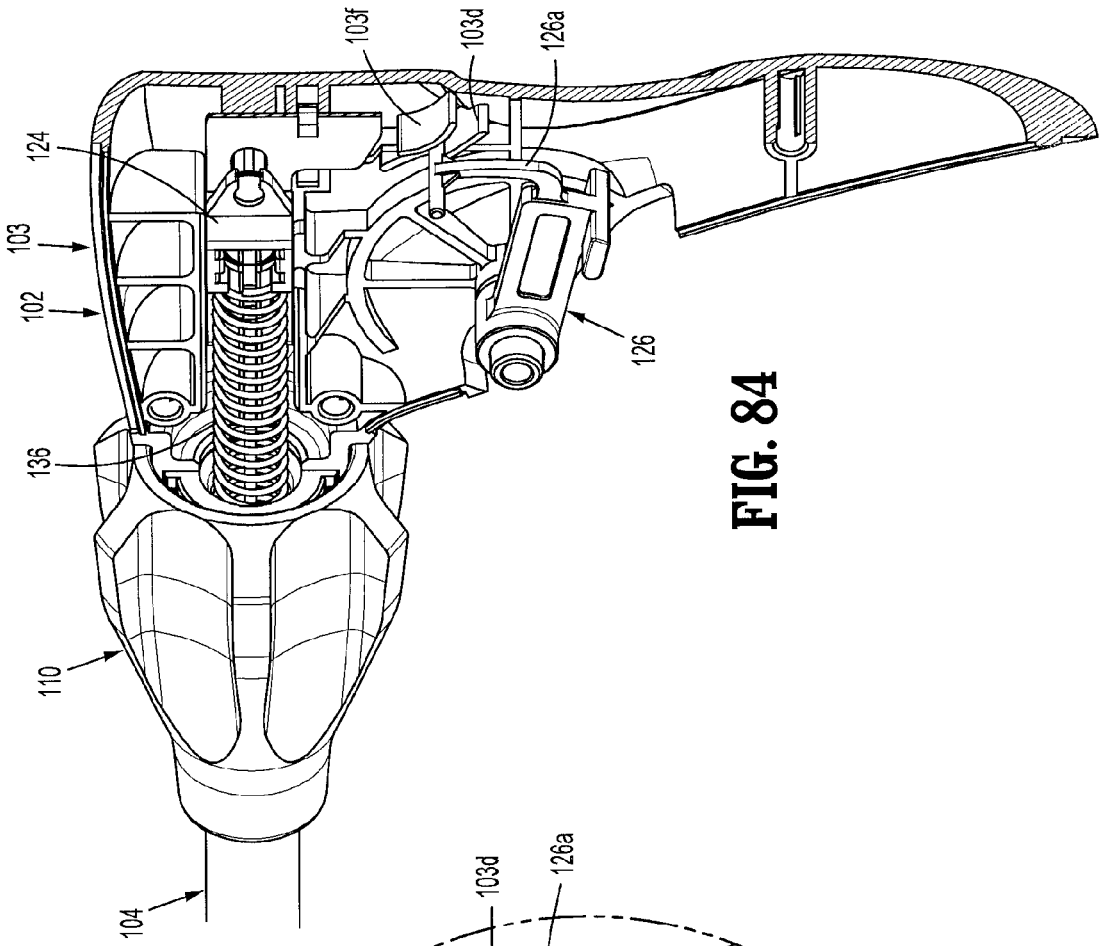
103f
103d
126a
124
103
102
126
136
110
104

FIG. 84

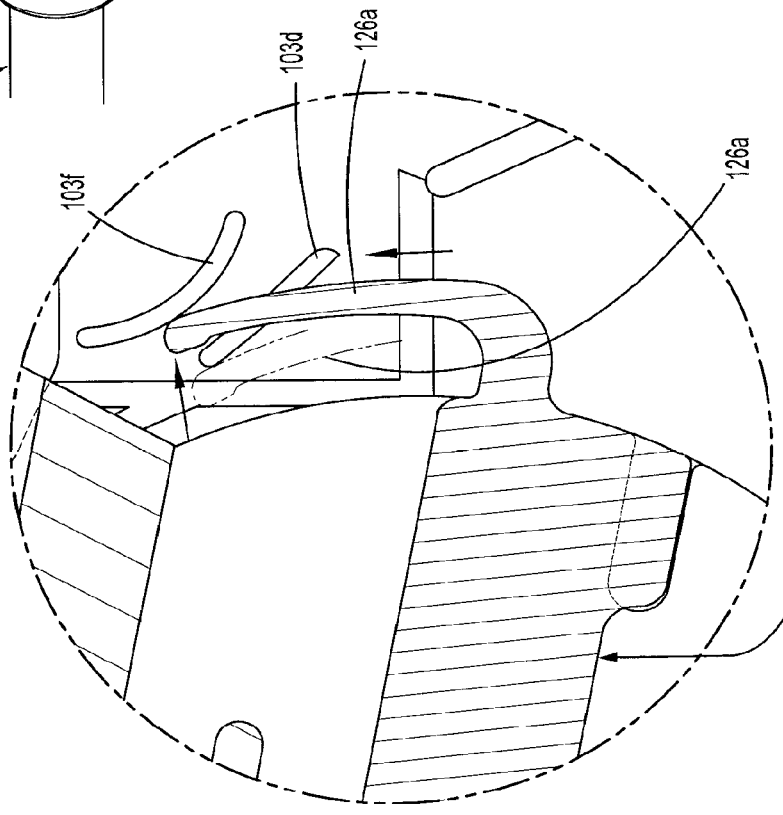
103d
126a
103f
126a
126

FIG. 83

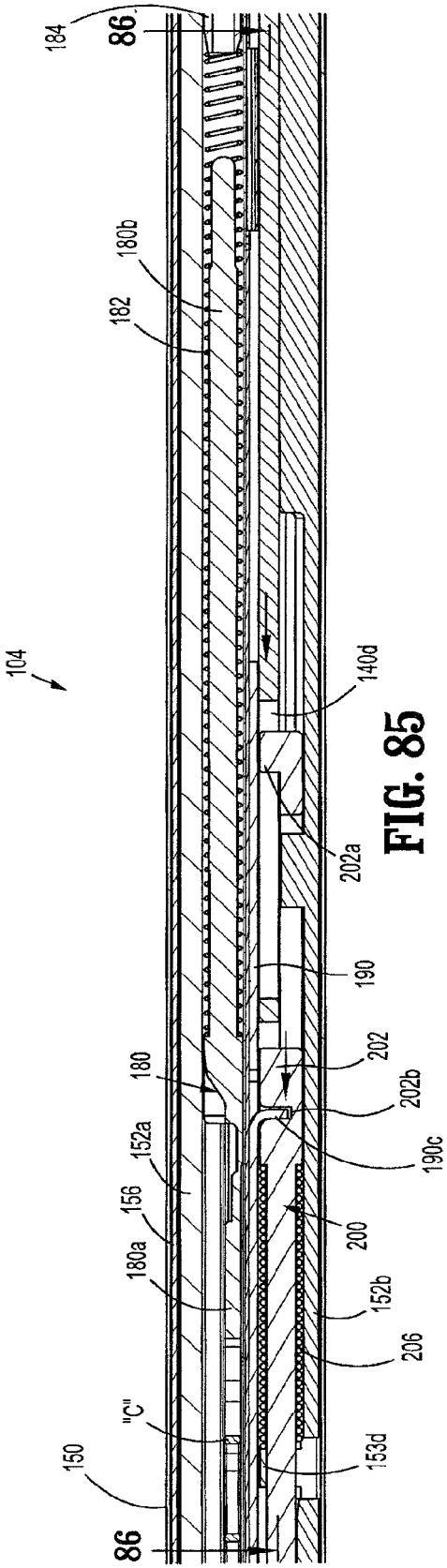
184
86
180b
182
104
140d
202a
190
202
180
202b
152a
190c
156
200
180a
152b
206
"C"
153d
150
86

FIG. 85

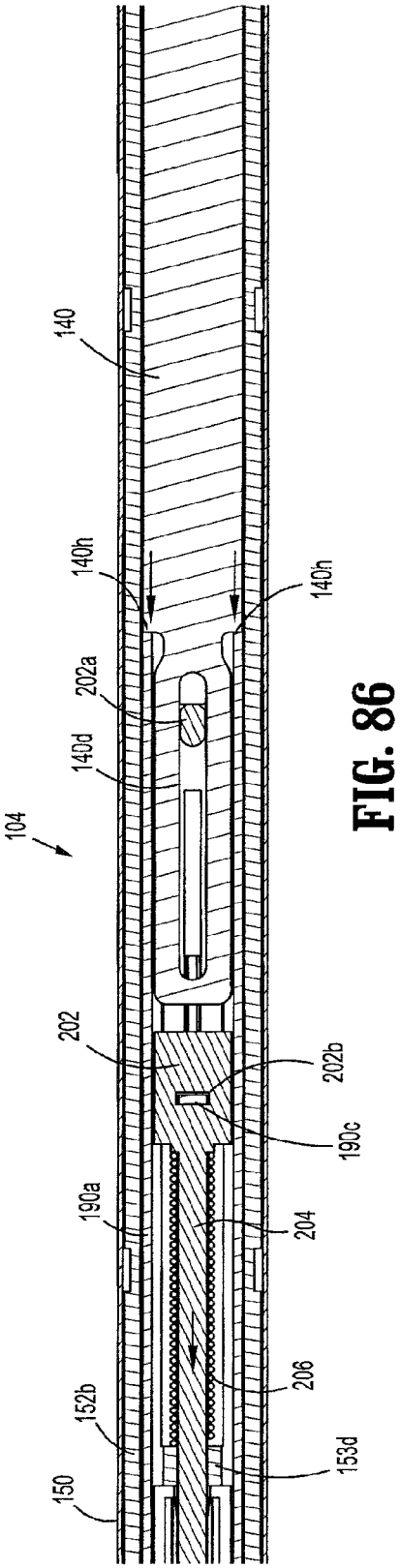
140
140h
140h
202a
140d
104
202
202b
190c
190a
204
206
152b
153d
150

FIG. 86

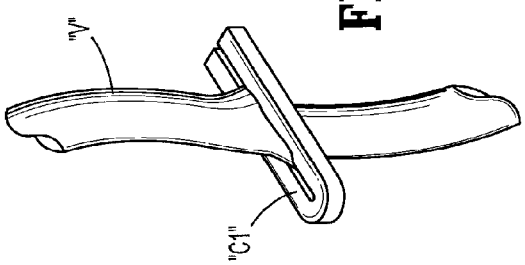

FIG. 90

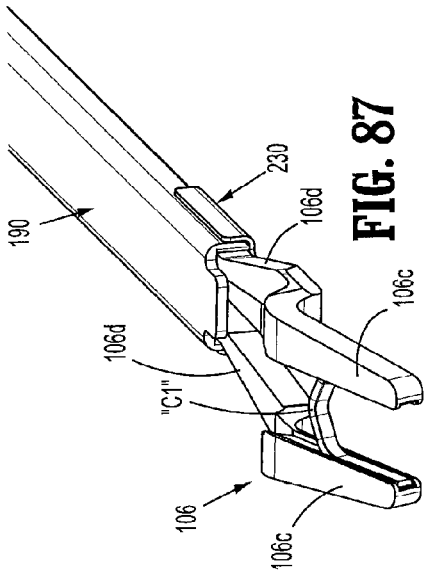

FIG. 87

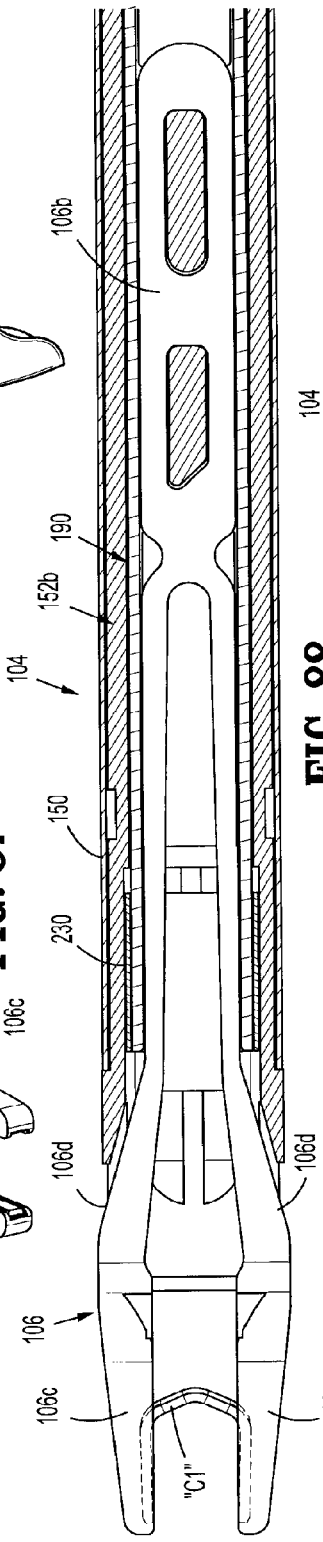

FIG. 88

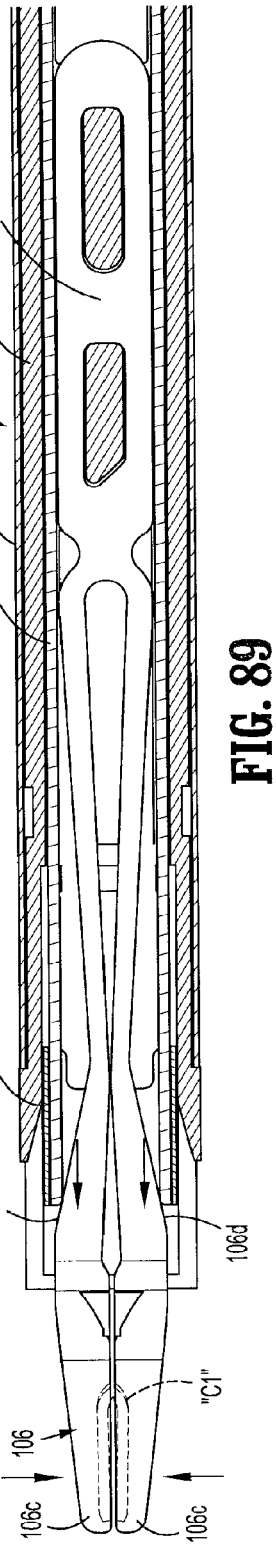

FIG. 89

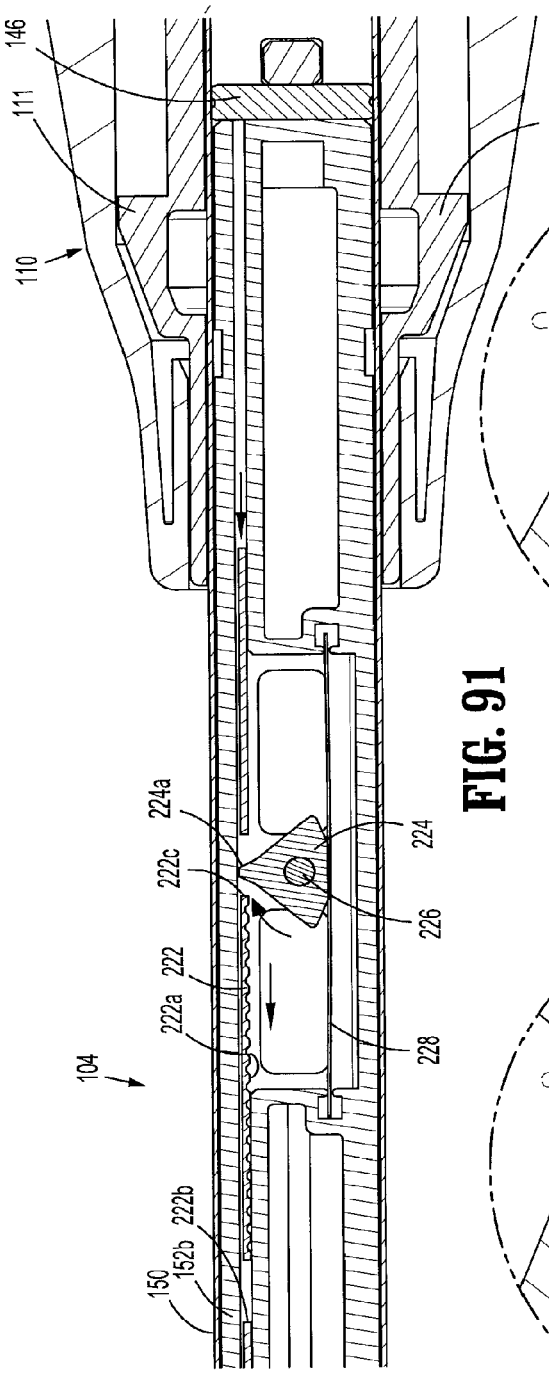

FIG. 91

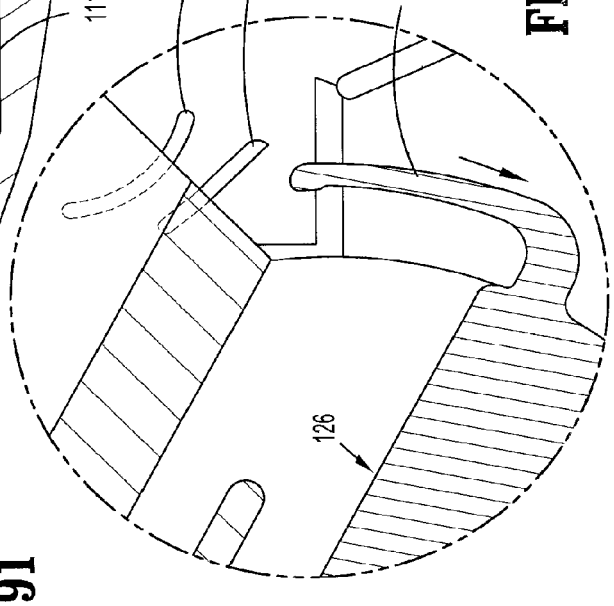

FIG. 93

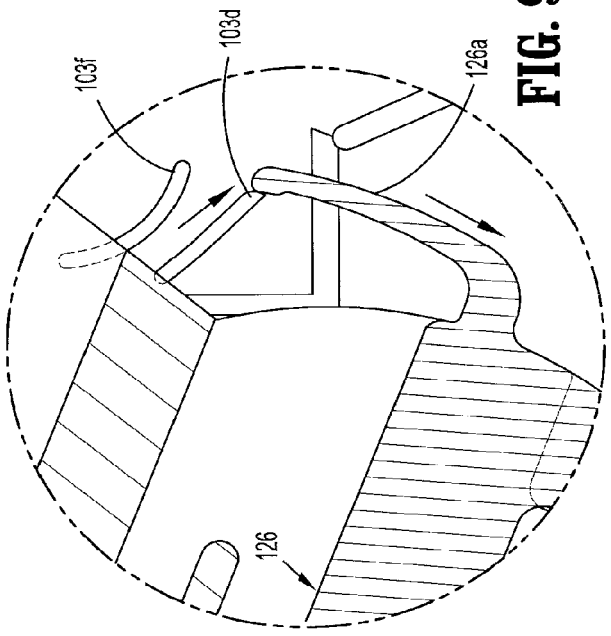

FIG. 92

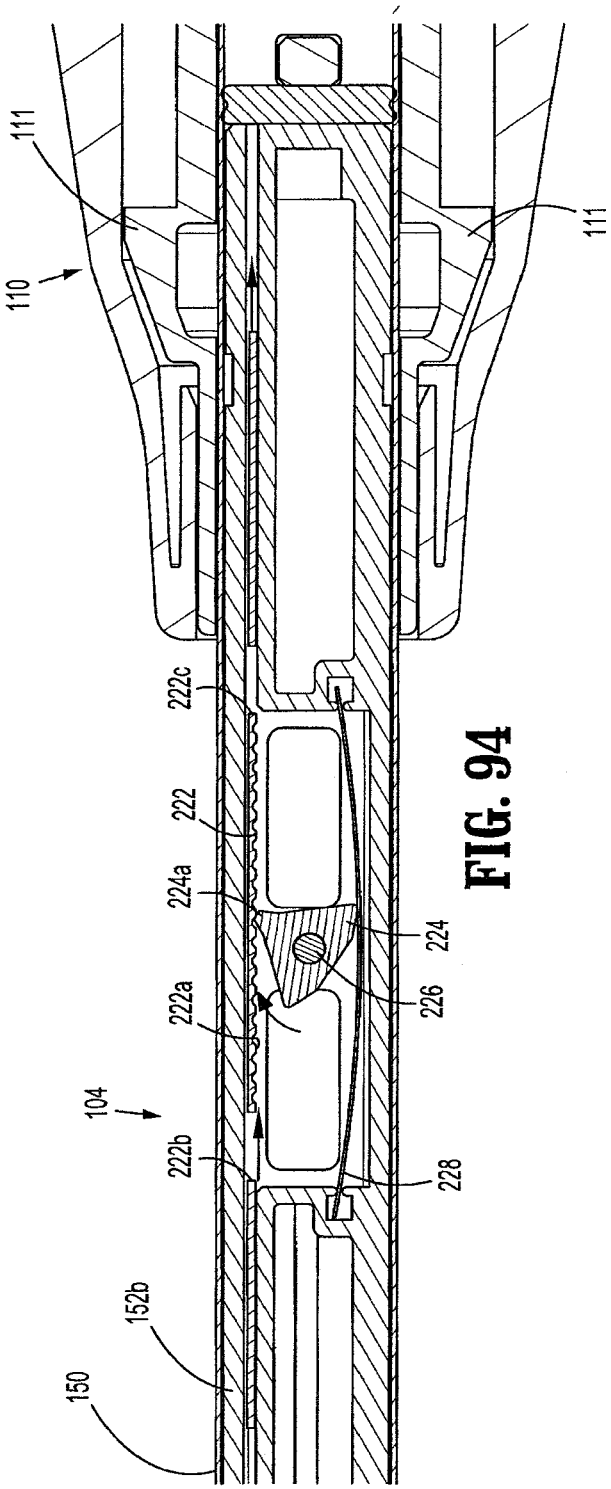

FIG. 94

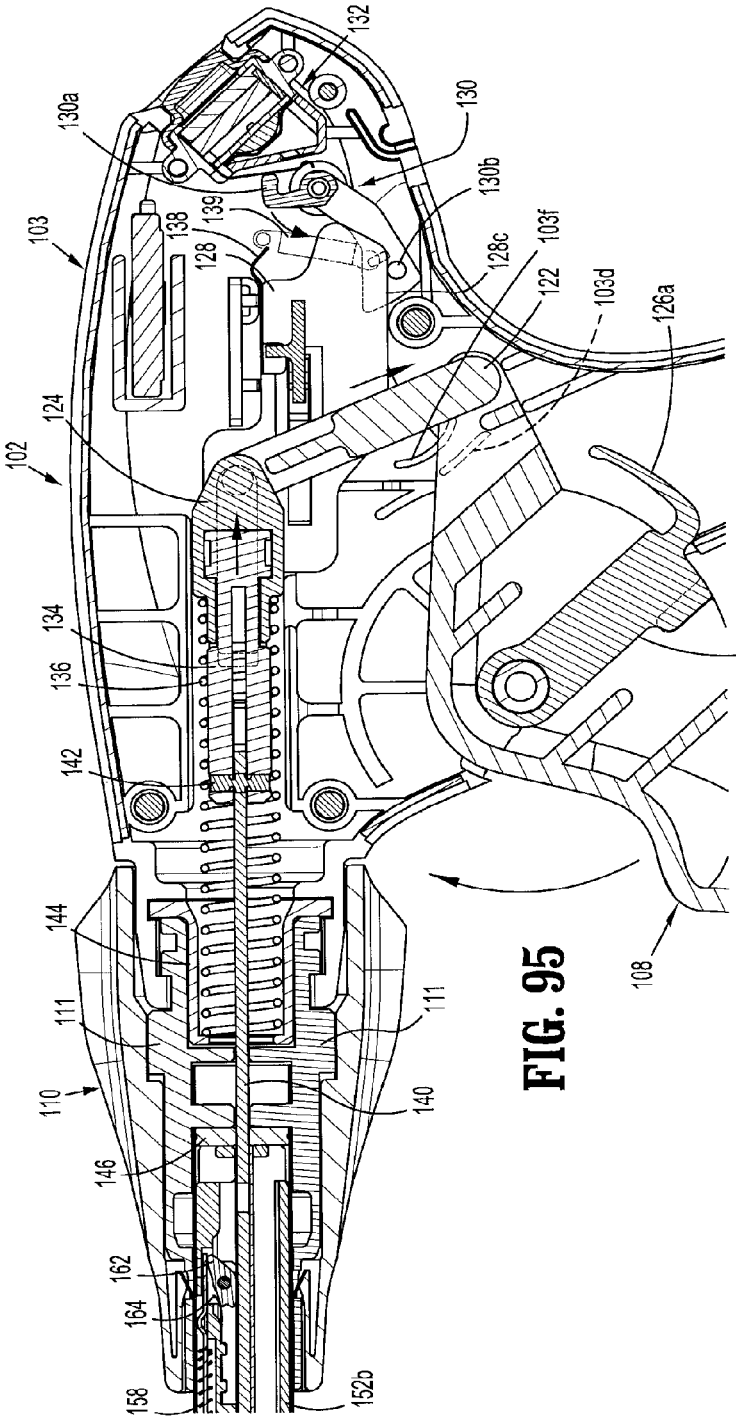
102
103
103d
103f
104
108
110
111
122
124
126
126a
128
128c
130
130a
130b
132
134
136
138
139
140
142
144
146
150
152b
153b
156
158
162
164
180
180a
190
190c
202
202a
204
206

FIG. 95

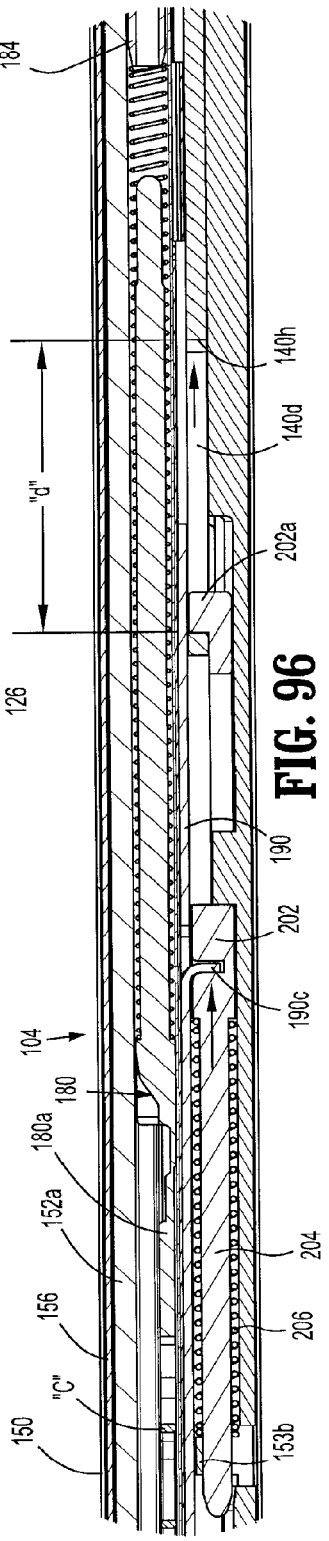
"C"
"d"
140d
140h
152a
184

FIG. 96

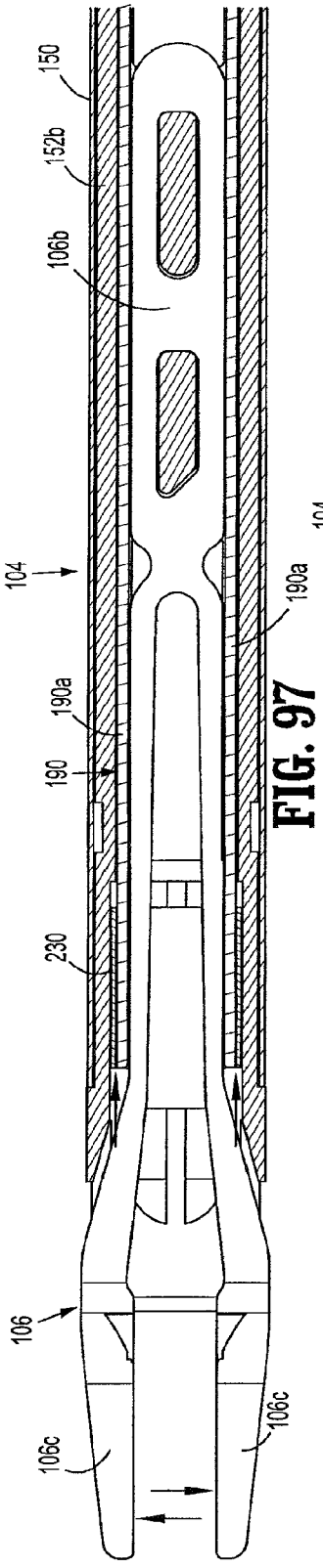

FIG. 97

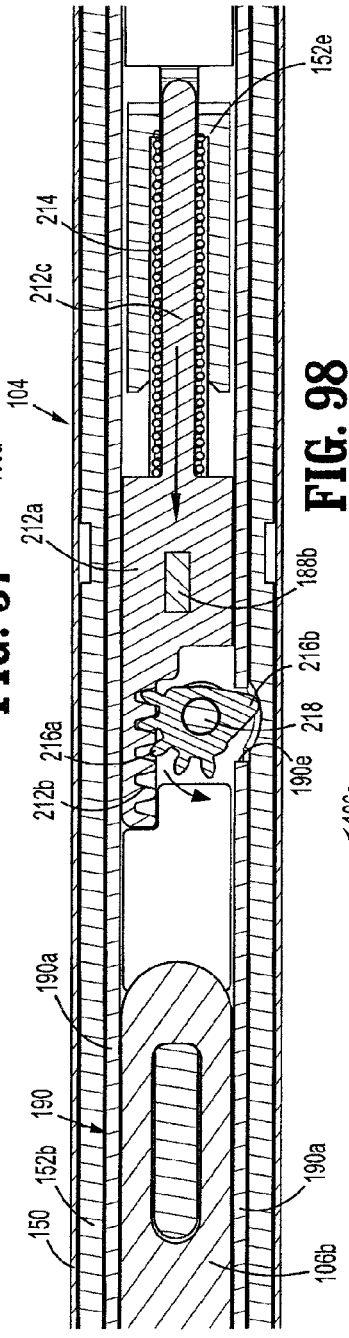

FIG. 98

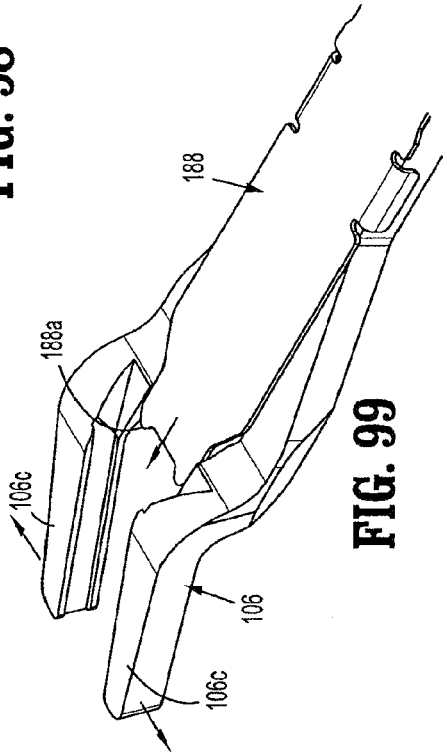

FIG. 99

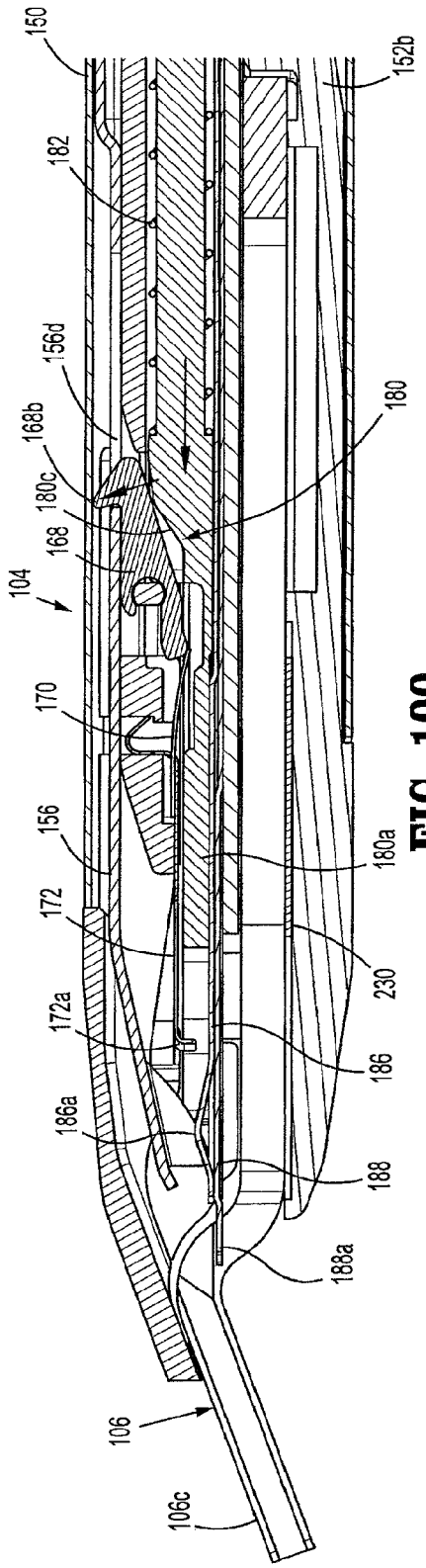

FIG. 100

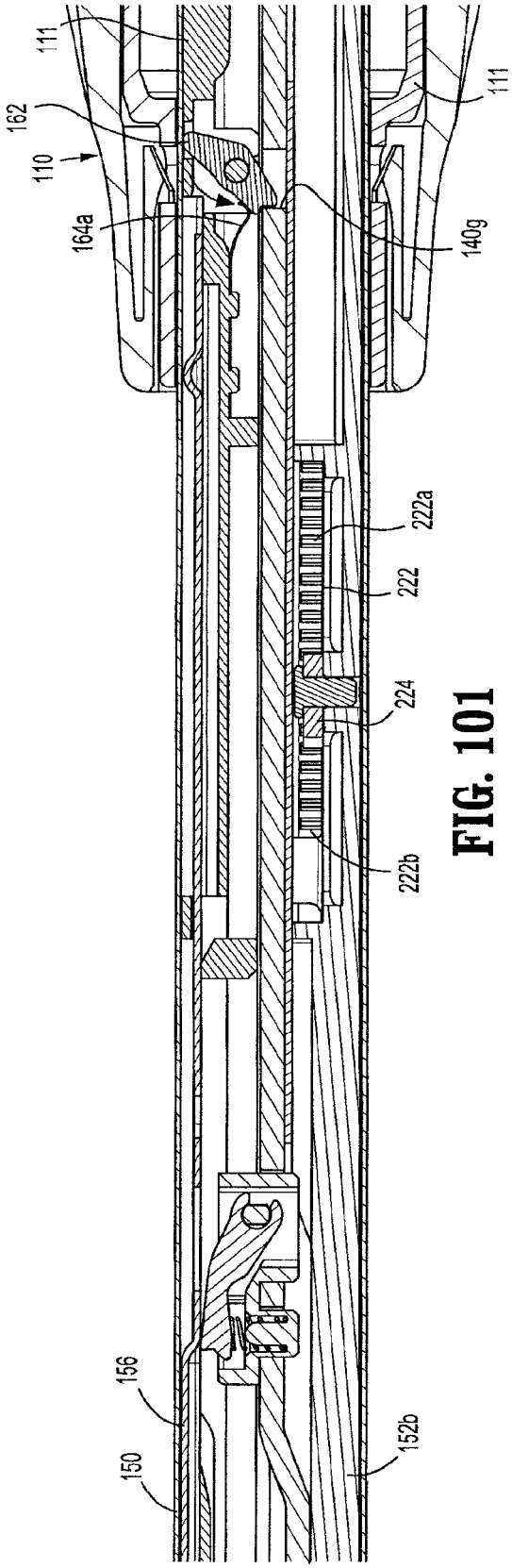

FIG. 101

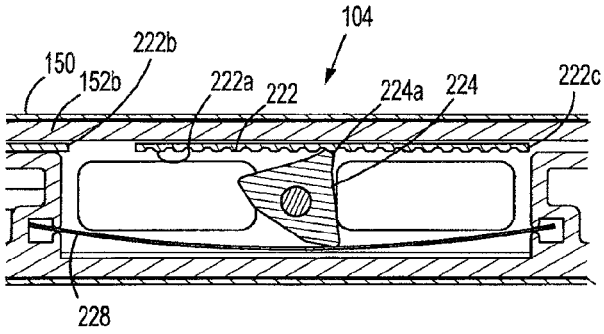

FIG. 102

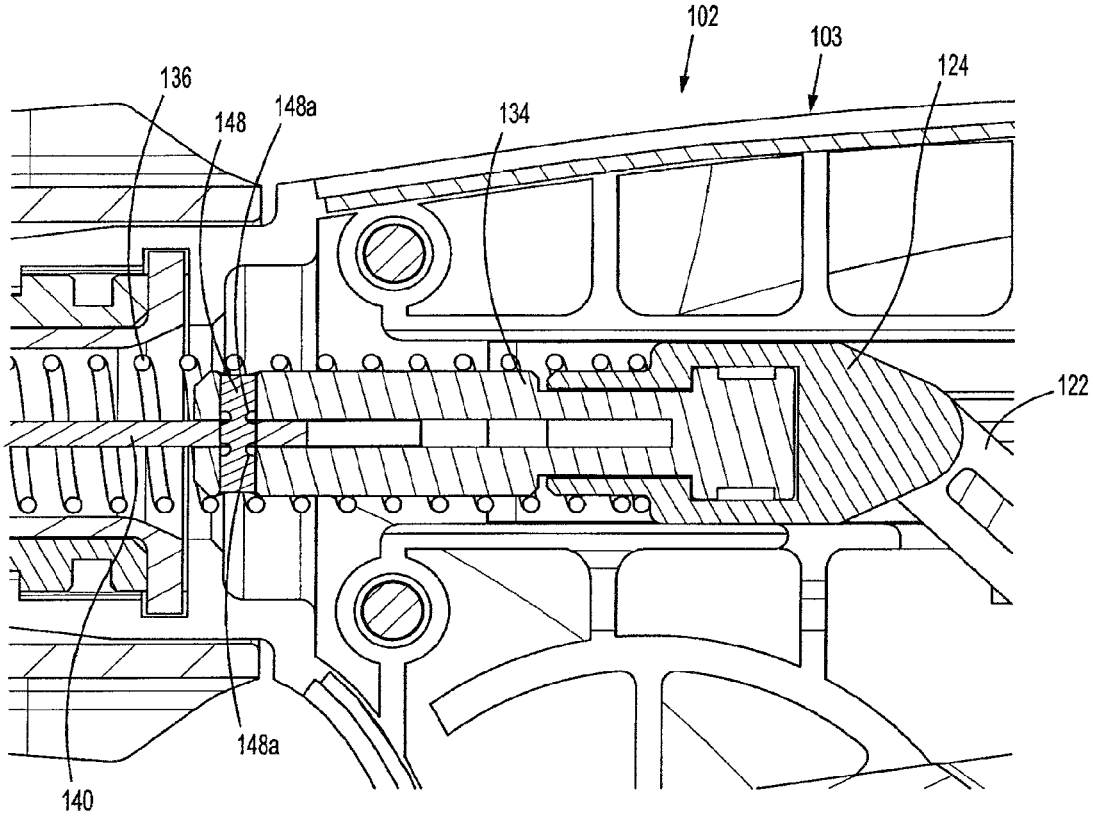

FIG. 103

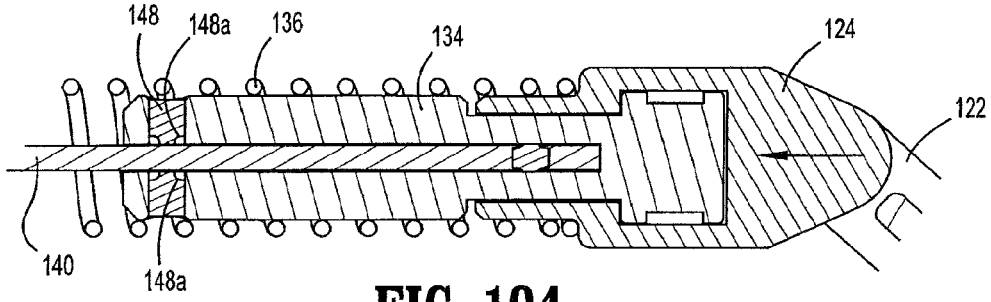

FIG. 104

ENDOSCOPIC SURGICAL CLIP APPLIER

CROSS-REFERENCE TO RELATED APPLICATIONS

This application is a continuation of U.S. patent application Ser. No. 13/760,635 filed Feb. 6, 2013, now U.S. Pat. No. 8,814,884, which is a divisional of U.S. patent application Ser. No. 12/055,446 filed Mar. 26, 2008, now U.S. Pat. No. 8,382,773, which claims benefit of U.S. Provisional Application No. 60/920,114 filed Mar. 26, 2007, and the disclosures of each of the above-identified applications are hereby incorporated by reference in their entirety.

BACKGROUND

1. Technical Field

The technical field relates to surgical clip appliers. More particularly, the present disclosure relates to an endoscopic surgical clip applier having a mechanism for stabilizing the jaw structure during the insertion of a surgical clip.

2. Description of Related Art

Endoscopic staplers and clip appliers are known in the art and are used for a number of distinct and useful surgical procedures. In the case of a laparoscopic surgical procedure, access to the interior of an abdomen is achieved through narrow tubes or cannulas inserted through a small entrance incision in the skin. Minimally invasive procedures performed elsewhere in the body are often generally referred to as endoscopic procedures. Typically, a tube or cannula device is extended into the patient's body through the entrance incision to provide an access port. The port allows the surgeon to insert a number of different surgical instruments therethrough using a trocar and for performing surgical procedures far removed from the incision.

During a majority of these procedures, the surgeon must often terminate the flow of blood or another fluid through one or more vessels. The surgeon will often apply a surgical clip to a blood vessel or another duct to prevent the flow of body fluids therethrough during the procedure. An endoscopic clip applier is known in the art for applying a single clip during an entry to the body cavity. Such clips are typically fabricated from a biocompatible material and are usually compressed over a vessel. Once applied to the vessel, the compressed clip terminates the flow of fluid therethrough.

Endoscopic clip appliers that are able to apply multiple clips in endoscopic or laparoscopic procedures during a single entry into the body cavity are described in commonly-assigned U.S. Pat. Nos. 5,084,057 and 5,100,420 to Green et al., which are both incorporated by reference in their entirety. Another multiple endoscopic clip applier is disclosed in commonly-assigned U.S. Pat. No. 5,607,436 by Pratt et al., the contents of which is also hereby incorporated by reference herein in its entirety. These devices are typically, though not necessarily, used during a single surgical procedure. U.S. patent application Ser. No. 08/515,341 now U.S. Pat. No. 5,695,502 to Pier et al., the disclosure of which is hereby incorporated by reference herein, discloses a resterilizable surgical clip applier. The clip applier advances and forms multiple clips during a single insertion into the body cavity. This resterilizable clip applier is configured to receive and cooperate with an interchangeable clip magazine so as to advance and form multiple clips during a single entry into a body cavity. One significant design goal is that the surgical clip be loaded between the jaws without any compression of the clip from the loading procedure. Such bending or torque of the clip during loading often has a number of unintended consequences. Such compression during loading may alter slightly the alignment of the clip between the jaws. This will cause the surgeon to remove the clip from between the jaws for discarding the clip. Additionally, such preloading compression may slightly compress parts of the clip and change a geometry of the clip. This may require the surgeon to remove the compressed clip from between the jaws for discarding the clip.

Endoscopic or laparoscopic procedures are often performed remotely from the incision. Consequently, application of clips may be complicated by a reduced field of view or reduced tactile feedback for the user at the proximal end of the device. It is therefore desirable to improve the operation of the instrument by providing an indication to the user of a firing of an individual clip, the depletion of the clips contained in the loading unit, or any other surgical event. It is also desirable to provide a surgical clip applier that promotes a successful loading of the clip and that wedges the jaws of the surgical clip applier open, then loads the clip between the jaws, in order to prevent any damage or excessive compression of the clip and prevents compression of the jaws on the clip before firing.

SUMMARY

The present disclosure relates to an endoscopic surgical clip applier.

According to an aspect of the present disclosure, an apparatus for application of surgical clips to body tissue is provided and includes a handle assembly; a shaft assembly extending distally from the handle assembly and defining a longitudinal axis; a plurality of surgical clips disposed within the shaft assembly; jaws mounted adjacent a distal end portion of the shaft assembly, the jaws including a pair of jaw members movable between a spaced-apart and an approximated position; a clip pusher bar configured to individually distally advance a surgical clip to the jaws while the jaw members are in the spaced apart position; a drive bar at least partially disposed within the handle assembly and the shaft assembly, the drive bar being longitudinally movable in response to actuation of a trigger of the handle assembly; and a drive channel positioned adjacent the first and second jaw members to move the jaw members to the approximated position.

The apparatus further includes a lockout system configured to selectively engage the clip pusher bar to prevent the clip pusher bar from returning to a home position and to prevent the trigger from completing a full stroke when the plurality of clips are substantially exhausted.

The lockout system may include a pusher-bar latch mechanism supported in the shaft assembly. In use, a lock-out bar of the latch mechanism may be actuated to engage the clip pusher bar when a final clip is exhausted. The lock-out bar may prevent the clip pusher bar from returning to the home position.

The apparatus may further include a clip follower slidably disposed within the shaft assembly at a location proximal of the plurality of clips. In use, the clip follower may urge the lock-out bar of the pusher-bar latch mechanism into engagement with the clip pusher bar when the final clip is exhausted.

The lockout system may include a rack having a plurality of ratchet teeth and being secured to the drive channel; and a pawl having at least one tooth and being disposed at a location to selectively engage the rack. The pawl may be biased into engagement with the rack. In use, as the drive channel is longitudinally reciprocated, the plurality of teeth may be

passed over the pawl, and the pawl may prevent inadvertent return of the drive channel before full actuation of the apparatus.

The apparatus lockout system may include a latch member operatively engageable by the clip pusher bar and the drive channel. The latch member may include a position that is out of engagement with the drive channel when the clip pusher bar is in the home position, and a position that is engaged with the drive channel when the clip pusher bar is in a non-home position. In use, when the clip pusher bar is prevented from returning to the home position by the lock-out bar, the latch member is engaged with the drive channel and prevents the drive channel from moving proximally, whereby the plurality of teeth of the rack are maintained in engagement with the pawl.

The apparatus may further include a wedge plate slidably supported in the shaft assembly. The wedge plate may include a distal end configured and dimensioned for placement between the jaw members when the jaw members are in the spaced-apart position. In use, the wedge plate may be moved in a proximal direction to withdraw the distal end thereof from between the jaw members when the drive channel is moved in a distal direction.

The apparatus may further include a gear operatively disposed between the wedge plate and the drive channel. In use, the gear may translate distal movement of the drive channel into proximal movement of the wedge plate and proximal movement of the drive channel into distal movement of the wedge plate.

The apparatus may be provided with a delay between the distal advancement of the drive bar and the distal advancement of the drive channel.

The apparatus may further include a trip mechanism supported on the drive bar. The trip mechanism may include a trip lever biased into contact with the clip pusher bar. In use, distal movement of the drive bar may move the trip mechanism until the trip lever thereof engages a lip of the clip pusher bar and in turn distally moves the clip pusher bar.

The apparatus may further include a shear pin operatively connected to the drive bar to transmit axial forces to the drive bar during movement of the trigger, wherein the shear pin includes at least one region of reduced strength. The shear pin may fail at the at least one region of reduced strength when a minimum predetermined shear force is exerted on the shear pin.

According to another aspect of the present disclosure, an apparatus for application of surgical clips to body tissue is provided and includes a handle assembly; a shaft assembly extending distally from the handle assembly; a plurality of surgical clips disposed within the shaft assembly, wherein each clip has an outer width; and jaws mounted adjacent a distal end portion of the shaft assembly, wherein the jaws include a pair of jaw members movable between a spaced-apart and an approximated position. The pair of jaw members have an outer width when in the spaced-apart position.

According to yet another aspect of the present disclosure, an apparatus for application of surgical clips to body tissue is provided. The apparatus includes a) a handle assembly; b) a shaft assembly extending distally from the handle assembly; c) a plurality of surgical clips disposed within the shaft assembly, each clip having an outer width; and d) jaws mounted adjacent a distal end portion of the shaft assembly, the jaws including a pair of jaw members movable between a spaced-apart and an approximated position, wherein when the pair of jaw members are in the spaced-apart position the pair of jaw members have an outer width, wherein a ratio of the outer width of the clip to the outer width of the pair of jaw members when in the spaced-apart position in less than or equal to 1:1.8.

According to still another aspect of the present disclosure, a method of applying surgical clips from a surgical clip applier is provided. The method includes the step of providing a surgical clip applier comprising at least a plurality of clips, jaws configured to receive and form said clips, and a trigger configured to actuate the jaws between an open position for receiving said clips and a closed position for forming said clips. The method further includes the steps of actuating the trigger from an open position to a closed position to load a first clip into the jaws and to move the jaws from the open position to the closed position to form said first clip; and then releasing the trigger to return the trigger to the open position and to return the jaws to the open position.

The trigger can only return to the open position after the trigger has been actuated to a fully closed position. The method may further comprise the step of providing a drive bar connected to the trigger, and wherein the step of actuating the trigger from the open position to the closed position may then cause the drive bar to move distally.

The method may further comprise the step of providing a pusher bar selectively connected to the drive bar, and wherein the step of actuating the trigger from the open position to the closed position may then cause the pusher bar to move distally.

The step of moving the pusher bar distally may include the step of a distal end of the pusher bar contacting a backspan of a distalmost clip and then moving the distalmost clip to a position between into the jaws. The method may further comprise the step of then disengaging the drive bar from the pusher bar, whereby the drive bar continues to move distally.

The method may further comprise the step of simultaneously moving a remainder of clips in a distal direction as said distalmost clip is moved into the jaws.

The method may further comprise the step of the drive bar then engaging a drive channel to move the drive channel in a distal direction.

The method may further comprise the step of then moving the pusher bar in a proximal direction.

The method may further comprise the step of then moving a wedge plate in a proximal direction such that a distal end of the wedge plate is withdrawn from between the jaws.

The method may further comprise the step of then engaging a distal end of the drive channel against the jaws to move the jaws from the open position to the closed position to form the clip disposed therein.

The method may further comprise the step of actuating a counter mechanism to indicate that an event has occurred.

The method may further comprise the step of then releasing the trigger to move the drive bar and drive channel in a proximal direction and to move the wedge plate in a distal direction.

The method may further comprise the step of actuating a lock member, following placement of a final clip into the jaws, that engages the pusher bar and prevents the pusher bar from moving to a fully proximal position.

BRIEF DESCRIPTION OF THE DRAWINGS

A particular embodiment of a surgical clip applier is disclosed herein with reference to the drawings wherein:

FIG. **1** is a perspective view of a surgical clip applier;

FIG. **2** is a further perspective view of the surgical clip applier of FIG. **1**, illustrating a rotation of an elongate tubular member thereof;

FIG. **3** is an enlarged, perspective view of the jaw structure of the surgical clip applier of FIGS. **1** and **2**;

FIG. **4**A is a top view of a surgical clip applier having a first overall length;

FIG. **4** is a top view of the surgical clip applier of FIGS. **1-3**, having a second overall length;

FIG. **5** is a side view of the surgical clip applier of FIGS. **1-4**;

FIG. **6** is a left-side, perspective view of a handle assembly of the surgical clip applier of FIGS. **1-4**, with a half of the body removed therefrom;

FIG. **7** is a right-side, perspective view of a handle assembly of the surgical clip applier of FIGS. **1-4**, with a half of the body removed therefrom;

FIG. **8** is an exploded, perspective view of the handle assembly of the surgical clip applier of FIGS. **1-4**, and a perspective view of a shaft assembly of the surgical clip applier of FIGS. **1-4** shown operatively associated therewith;

FIG. **9** is an exploded, perspective view of the shaft assembly of the surgical clip applier of FIGS. **1-4**;

FIG. **10** is a perspective view of a tactile feedback member of the surgical clip applier of FIGS. **1-4**;

FIG. **11** is an exploded, perspective view of the indicated area of detail of FIG. **9**, illustrating a trip mechanism of the shaft assembly;

FIG. **12** is an exploded, perspective view of the indicated area of detail of FIG. **9**, illustrating a latch lock-out of the shaft assembly;

FIG. **13** is a perspective view of the indicated area of detail of FIG. **9**, illustrating a joint slider the shaft assembly;

FIG. **14** is an exploded, perspective view of the indicated area of detail of FIG. **9**, illustrating a pusher-bar latch mechanism of the shaft assembly;

FIG. **15** is an exploded, perspective view of the indicated area of detail of FIG. **9**, illustrating a wedge plate rack mechanism of the shaft assembly;

FIG. **16** is a partially exploded, perspective view of a proximal end of the surgical clip applier of FIGS. **1-4**, illustrating a joint extension disposed between the shaft assembly and the handle assembly;

FIG. **17** is an assembled, perspective view of a proximal end of the surgical clip applier of FIG. **16**, illustrating a joint extension disposed between the shaft assembly and the handle assembly;

FIG. **18** is a rear, perspective, cross-sectional view of the surgical clip applier of FIGS. **1-4**, as taken through **18-18** of FIG. **5**;

FIG. **19** is an enlarged view of the indicated area of detail of FIG. **18**;

FIG. **20** is a rear, elevational, cross-sectional view of the surgical clip applier of FIGS. **1-4**, as taken through **20-20** of FIG. **5**;

FIG. **21** is a front, perspective view of the shaft assembly of the surgical clip applier of FIGS. **1-4**, with an outer tubular member removed therefrom for illustrative purposes;

FIG. **22** is an enlarged, perspective view of the indicated area of detail of FIG. **21**;

FIG. **23** is an enlarged, perspective view of the indicated area of detail of FIG. **21**;

FIG. **24** is a front, perspective view of the shaft assembly of the surgical clip applier of FIGS. **1-4**, with an upper housing removed therefrom for illustrative purposes;

FIG. **25** is an enlarged, perspective view of the indicated area of detail of FIG. **24**;

FIG. **26** is an enlarged, perspective view of the indicated area of detail of FIG. **24**;

FIG. **27** is an enlarged, perspective view of a distal end of the shaft assembly of FIG. **24**;

FIG. **28** is a rear, perspective view of the shaft assembly of the surgical clip applier of FIGS. **1-4**, with a pusher bar, a clip advance mechanism and a plurality of clips removed therefrom;

FIG. **29** is an enlarged, perspective view of the indicated area of detail of FIG. **28**;

FIG. **30** is an enlarged, perspective view of the indicated area of detail of FIG. **28**;

FIG. **31** is a front, perspective view of the shaft assembly of the surgical clip applier of FIGS. **1-4**, with a lower housing pusher bar, a clip advance mechanism and a plurality of clips removed therefrom;

FIG. **32** is an enlarged, perspective view of the indicated area of detail of FIG. **31**;

FIG. **33** is a perspective view of the indicated area of detail of FIG. **31**;

FIG. **34** is a bottom, front, perspective view of the shaft assembly of the surgical clip applier of FIGS. **1-4**, with a lower housing removed therefrom;

FIG. **35** is an enlarged, perspective view of the indicated area of detail of FIG. **34**;

FIG. **36** is an enlarged, perspective view of the indicated area of detail of FIG. **34**;

FIG. **37** is a rear, perspective view of the shaft assembly of the surgical clip applier of FIGS. **1-4**, with a drive channel and wedge plate removed therefrom;

FIG. **38** is an enlarged, perspective view of the indicated area of detail of FIG. **34**;

FIG. **39** is a bottom, front, perspective view of the distal end of the shaft assembly of the surgical clip applier of FIGS. **1-4**, illustrating the upper housing, the wedge plate and a drive channel in an assembled condition;

FIG. **40** is an enlarged, rear perspective view of a pawl and rack assembly of the shaft assembly with the drive bar removed;

FIG. **41** is an enlarged, perspective view of the indicated area of detail of FIG. **39**;

FIG. **42** is an enlarged, perspective view of the indicated area of detail of FIG. **39**;

FIG. **43** is a bottom, front, perspective view of the distal end of the shaft assembly of FIG. **39**, with the wedge plate and the drive channel, clip stack and follower removed therefrom;

FIG. **44** is an enlarged, perspective view of the indicated area of detail of FIG. **43**;

FIG. **45** is an enlarged, perspective view of the indicated area of detail of FIG. **43**;

FIG. **46** is an enlarged, perspective view of the indicated area of detail of FIG. **43**;

FIG. **47** is a longitudinal, elevational, cross-sectional view of the surgical clip applier of FIGS. **1-4**;

FIG. **48** is an enlarged, elevational, cross-sectional view of the indicated area of detail of FIG. **47**;

FIG. **49** is an enlarged, elevational, cross-sectional view of the indicated area of detail of FIG. **47**;

FIG. **50** is a longitudinal, cross-sectional view as taken through **50-50** of FIG. **49**;

FIG. **51** is a transverse, cross-sectional view as taken through **51-51** of FIG. **48**;

FIG. **52** is an enlarged, elevational, cross-sectional view of the indicated area of detail of FIG. **49**;

FIG. **53** is a longitudinal, cross-sectional view taken through **53-53** of FIG. **52**;

FIG. **54** is an enlarged, elevational, cross-sectional view of the indicated area of detail of FIG. **49**;

FIG. **55** is a longitudinal, cross-sectional view taken through **55-55** of FIG. **54**;

FIG. **56** is an enlarged, elevational, cross-sectional view of the indicated area of detail of FIG. **49**;

FIG. **57** is a longitudinal, cross-sectional view taken through **57-57** of FIG. **56**;

FIG. **58** is a transverse, cross-sectional view as taken through **58-58** of FIG. **54**;

FIG. **59** is a transverse, cross-sectional view as taken through **59-59** of FIG. **56**;

FIG. **60** is an enlarged, elevational, cross-sectional view of the indicated area of detail of FIG. **49**;

FIG. **61** is a longitudinal, cross-sectional view taken through **61-61** of FIG. **60**;

FIG. **62** is a longitudinal, elevational, cross-sectional view of the surgical clip applier of FIGS. **1-4**, illustrating a first stage of an initial stroke of the trigger of the handle assembly;

FIG. **63** is an enlarged, elevational, cross-sectional view of the of detail **52** of FIG. **49**, during the first stage of the initial stroke of the trigger of the handle assembly;

FIG. **64** is a longitudinal, cross-sectional view taken through **64-64** of FIG. **63**;

FIGS. **65** and **66** are enlarged, elevational, cross-sectional views of detail **60** of FIG. **49**, during the first stage of the initial stroke of the trigger of the handle assembly;

FIG. **67** is a longitudinal, elevational, cross-sectional view of the surgical clip applier of FIGS. **1-4**, illustrating a second stage of an initial stroke of the trigger of the handle assembly;

FIG. **68** is an enlarged, elevational, cross-sectional view of the indicated area of detail of FIG. **67**, during the second stage of the initial stroke of the trigger of the handle assembly;

FIG. **69** is an enlarged, elevational, cross-sectional view of detail **60** of FIG. **49**, during the second stage of the initial stroke of the trigger of the handle assembly;

FIG. **70** is an enlarged, elevational, cross-sectional view of detail **52** of FIG. **49**, during the second stage of the initial stroke of the trigger of the handle assembly;

FIG. **71** is an enlarged, elevational, cross-sectional view of detail **54** of FIG. **49**, during the second stage of the initial stroke of the trigger of the handle assembly;

FIG. **72** is a longitudinal, cross-sectional view taken through **72-72** of FIG. **71**;

FIG. **73** is an enlarged, elevational, cross-sectional view of detail **52** of FIG. **49**, during the second stage of the initial stroke of the trigger of the handle assembly;

FIGS. **74** and **75** are enlarged, elevational, cross-sectional views of detail **60** of FIG. **49**, during the second stage of the initial stroke of the trigger of the handle assembly;

FIG. **76** is an enlarged, elevational, cross-sectional view of the of detail **52** of FIG. **49**, during the second stage of the initial stroke of the trigger of the handle assembly;

FIG. **77** is an enlarged, elevational, cross-sectional view of the detail **56** of FIG. **49**, during the second stage of the initial stroke of the trigger of the handle assembly;

FIG. **78** is a longitudinal, cross-sectional view taken through **78-78** of FIG. **77**;

FIG. **79** is a front, perspective view of the jaws of the surgical clip applier having the wedge plate interposed therebetween;

FIG. **80** is a front, perspective view of the jaws of the surgical clip applier illustrating the wedge plate being withdrawn from therebetween;

FIG. **81** is a longitudinal, elevational, cross-sectional view of the handle assembly of the surgical clip applier of FIGS. **1-4**, illustrating a third stage of an initial stroke of the trigger of the handle assembly;

FIG. **82** is an enlarged, elevational, cross-sectional view of the indicated area of detail of FIG. **81**;

FIG. **83** is an enlarged, elevational, cross-sectional view of the indicated area of detail of FIG. **81**;

FIG. **84** is a rear, perspective, partial cross-sectional view of the handle assembly during the third stage of the initial stroke of the trigger of the handle assembly;

FIG. **85** is an enlarged, elevational, cross-sectional view of detail **54** of FIG. **49**, during third stage of the initial stroke of the trigger of the handle assembly;

FIG. **86** is a longitudinal, cross-sectional view taken through **86-86** of FIG. **85**;

FIG. **87** is a front, perspective view of the jaws of the surgical clip applier illustrating a drive channel and a drive plate operatively associated therewith;

FIG. **88** is a longitudinal, top-plan, cross-sectional view of a distal end of the shaft assembly of the surgical stapling device of FIGS. **1-4**, illustrating an un-approximated position of the jaws;

FIG. **89** is a longitudinal, top-plan, cross-sectional view of a distal end of the shaft assembly of the surgical stapling device of FIGS. **1-4**, illustrating an approximated position of the jaws;

FIG. **90** is a perspective view of the body vessel including a clip of the surgical stapling device of FIGS. **1-4**, applied thereto;

FIG. **91** is a longitudinal, cross-sectional view taken through **64-64** of FIG. **63**, illustrating an operation the pawl and rack assembly of FIG. **40**;

FIGS. **92** and **93** are enlarged, elevational, cross-sectional views of detail **83** of FIG. **81**, illustrating the operation of the tactile feedback element;

FIG. **94** is a longitudinal, cross-sectional view taken through **64-64** of FIG. **63**, illustrating a further operation a pawl and rack assembly;

FIG. **95** is a longitudinal, elevational, cross-sectional view of the handle assembly of the surgical clip applier of FIGS. **1-4**, illustrating a release stroke of the trigger of the handle assembly;

FIG. **96** is an enlarged, elevational, cross-sectional view of detail **54** of FIG. **49**, during the release stoke of the trigger of the handle assembly;

FIG. **97** is a longitudinal, top-plan, cross-sectional view of a distal end of the shaft assembly of the surgical stapling device of FIGS. **1-4**, illustrating the un-approximation of the jaws during the release stoke of the trigger of the handle assembly;

FIG. **98** is a longitudinal, cross-sectional view taken through **78-78** of FIG. **77**, illustrating the operation of the wedge plate rack mechanism during the release stoke of the trigger of the handle assembly;

FIG. **99** is a rear, perspective view of the jaws of the surgical clip applier illustrating the wedge plate being inserted therebetween;

FIG. **100** is an enlarged, elevational, cross-sectional view of detail **60** of FIG. **49**, beginning a lockout phase after the final clip has been fired;

FIG. **101** is an enlarged, elevational, cross-sectional view of the of detail **52** of FIG. **49**, during the release stroke of the trigger of the handle assembly and engaging a lockout mechanism;

FIG. **102** is a longitudinal, cross-sectional view of FIG. **64**, illustrating an operation a pawl and rack assembly during the lockout phase of the device;

FIG. **103** is an enlarged, longitudinal, cross-sectional view of the handle assembly, illustrating the operation of a drive assembly after the lockout mechanism has been engaged; and

FIG. **104** is an enlarged, longitudinal, cross-sectional view of the handle assembly, illustrating the operation of a shear pin with the drive assembly breaking through the lockout mechanism.

DETAILED DESCRIPTION OF EMBODIMENTS

Embodiments of surgical clip appliers in accordance with the present disclosure will now be described in detail with reference to the drawing figures wherein like reference numerals identify similar or identical structural elements. As shown in the drawings and described throughout the following description, as is traditional when referring to relative positioning on a surgical instrument, the term "proximal" refers to the end of the apparatus which is closer to the user and the term "distal" refers to the end of the apparatus which is further away from the user.

Referring now to FIGS. **1-5**, a surgical clip applier in accordance with an embodiment of the present disclosure is generally designated as **100**. Surgical clip applier **100** generally includes a handle assembly **102** and an endoscopic portion including a shaft assembly **104** extending distally from handle assembly **102**.

Shaft assembly **104** may have various outer diameters such as, for example, about 5 mm or about 10 mm, depending on intended use. Further, shaft assembly **104** may have various elongated (see FIG. **4**A) or shortened lengths (see FIGS. **4** and **5**) depending on intended use, such as, for example, in bariatric surgery. In one embodiment, in bariatric surgery, elongated tubular member **104** may have a length of between about 30 cm and about 40 cm. However one skilled in the art should appreciate that shaft assembly **104** may have any length in excess of about 30 cm and the present disclosure is not limited to any of the above identified lengths.

Surgical clip applier **100** includes a pair of jaws **106** mounted on a distal end of shaft assembly **104** and actuatable by a trigger **108** of handle assembly **102**. Jaws **106** are formed of a suitable biocompatible material such as, for example, stainless steel or titanium. Notably, in some embodiments, when jaws **106** are in an open or un-approximated condition relative to each other, a maximum width of jaws **106** measures substantially less than or equal to an outer diameter of shaft assembly **104** to allow for insertion of a distal end of surgical clip applier **100** through a trocar during endoscopic surgery or an opening or orifice in a body during open surgery.

Jaws **106** are mounted in the distal end of shaft assembly **104** such that they are longitudinally stationary relative thereto. A knob **110** may be rotatably mounted on a distal end of handle assembly **102** and affixed to shaft assembly **104** to transmit and/or provide 360° rotation to shaft assembly **104** and jaws **106** about a longitudinal axis thereof (see FIG. **2**). Referring momentarily to FIG. **3**, jaws **106** define a channel **106***a* therebetween for receipt of a surgical clip (not shown) therein.

Referring now to FIGS. **6-8**, handle assembly **102** of surgical clip applier **100** is shown. Handle assembly **102** includes a housing **103** having a first or right side half-section **103***a* and a second or left side half-section **103***b*. Handle assembly **102** includes a trigger **108** pivotably supported between right side half-section **103***a* and left side half-section **103***b*. Handle assembly **102** defines a window **103***c* formed in housing **103** for supporting and displaying a counter mechanism **132***a*, as will be discussed in greater detail below. Housing **103** of handle assembly **102** may be formed of a suitable plastic material.

Housing **103** supports a drive assembly **120** between right side half-section **103***a* and left side half-section **103***b*. Drive assembly **120** includes a wishbone link **122** having a first end pivotally connected to trigger **108**, and a second end pivotally connected to a yoke **124**. As seen in FIGS. **6-9**, drive assembly **120** further includes a plunger **134** rotatably connected to yoke **124**, and a spring **136** supported on plunger **134**. Plunger **134** defines a longitudinal slot **134***a* (see FIG. **9**) configured and adapted to receive a proximal end of a drive bar **140** therein.

Drive bar **140** is pinned to plunger **134** via a shear pin **142**, the structure and function of which will be described in greater detail below. A cap **144** is provided through which drive bar **140** extends. A knob insert **111** is provided and is configured and adapted for rotational support in a distal end of housing **103** and for support of cap **144** therewithin. Knob insert **111** is keyed to knob **110** such that rotation of knob **110** results in concomitant rotation of knob insert **111**. A seal **146** is provided to create an air-tight seal between drive bar **140** and an outer tube **150**.

As seen in FIGS. **6-8**, **48**, **62**, **67**, **81**, **83**, **84**, **92**, **93** and **95**, handle assembly **102** further includes an audible/tactile feedback member **126** operatively associated with trigger **108** so as to rotate together with and about a common axis as trigger **108**. Feedback member **126** includes a deflectable arm **126***a*. In operation, as trigger **108** is actuated, arm **126***a* of feedback member **126** rides over and/or along a rib **103***d* formed in at least one of right side half-section **103***a* and left side half-section **103***b*. As will be discussed in greater detail below, as arm **126***a* reaches the end of rib **103***d*, arm **126***a* snaps over the end of rib **103***d* and creates and audible sound/click and/or a tactile vibration as arm **126***a* comes into contact with a surface **103***f* of right side half-section **103***a* and left side half-section **103***b*.

As seen in FIGS. **6-8**, housing **103** further supports an actuator plate **128** on right side half-section **103***a*. Actuator plate **128** includes a protrusion **128***a* configured and adapted for slidable engagement in a slot **103***e* defined in right side half-section **103***a* of housing **103**. Actuator plate **128** defines a longitudinally oriented slot **128***b* therein for slidably receiving a boss **122***a* of wishbone link **122**. Actuator plate **128** further defines a counter actuation surface **128***c* for slidably engaging an arm **130***b* of a counter actuation lever **130**. Counter actuation lever **130** is pivotally supported within housing **103**.

As seen in FIGS. **6-8**, **48**, **62**, **67**, **81**, **82**, and **95**, counter actuation lever **130** includes a first arm **130***a* configured and adapted to operatively, selectively engage a counter mechanism **132** supported in housing **103** and visible through window **103***c* defined in housing **103**. Counter actuation lever **130** further includes a second arm **130***b* configured and adapted to operatively, slidably engage actuation surface **128***c* of actuation plate **128**. A biasing member, in the form of a spring **139**, is provided to bias second arm **130***b* of counter actuation lever **130** against counter actuation surface **128***c* of actuator plate **128**.

In operation, as will be described in greater detail below, as trigger **108** is squeezed, trigger **108** causes wishbone link **122** to be advanced distally, causing yoke **124** to be advanced distally. When boss **122***a* of wishbone link **122** reaches the end of slot **128***b* of actuator plate **128**, boss **122***a* forces actuator plate **128** in a distal direction thereby actuating counter actuation lever **130** to activate counter mechanism **132**. In particular, when actuator plate **128** is moved distally a sufficient distance, second arm **130***b* of counter actuation lever **130** clears counter actuation surface **128***c* of actuator plate **128** and is urged in a first or clockwise direction by spring **139** resulting in first arm **130***a* of counter actuation lever **130** engaging counter mechanism **132**. When actuator

plate **128** is moved proximally a sufficient distance, second arm **130***b* of counter actuation lever **130** is cammed by counter actuation surface **128***c* of actuator plate **128** and is urged in a second or counter-clockwise direction thereby resulting in first arm **130***a* of counter actuation lever **130** disengaging counter mechanism **132**.

Counter mechanism **132** includes a display **132***a*, a processor **132***b*, and an energy source **132***c* in the form of a battery or the like.

Display **132***a* may be any device known in the art to provide an indication of an event. The event may be related to the procedure or the operation of the clip applier **100**. Display **132***a* may be a liquid crystal display (LCD), a plasma display, one or more light emitting diodes (LEDs), a luminescent display, a multi-color display, a digital display, an analog display, a passive display, an active display, a so called "twisted nematic" display, a so called "super twisted nematic" display, a "dual scan" display, a reflective display, a backlit display, an alpha numeric display, a monochrome display, a so called "Low Temperature Polysilicon Thin Film Transistor" (LPTS TFT) display, or any other suitable display **132***a* that indicates a parameter, information or graphics related to the procedure or clip applier **100**.

In one embodiment, display **132***a* is a liquid crystal display which may be a black & white or color display that displays one or more operating parameters of clip applier **100** to the surgeon. In one embodiment, the operating parameter displayed may be an amount or number of remaining clips, a number of clips that have been used, a position parameter, a surgical time of usage, or any other parameter of the procedure. The display **132***a* may display text, graphics or a combination thereof.

In one embodiment, counter mechanism **132** may have a tab, preferably made from a Mylar or another polymeric insulating material, disposed between battery or energy source **132***c* and a contact of processor **132***b* which prevents the battery or energy source **132***c* from becoming drained during storage. The tab may extend out of housing **103** of surgical clip applier **100** in order to allow for easy removal of the tab therefrom. Once the tab is removed, battery or energy source **132***c* comes into electrical contact with the contact of processor **132***b* and in turn energizes display **132***a*.

Display **132***c* may include a lens or the like for magnifying the parameters displayed thereon. The lens of display **132***a* may magnify the display to any desired size in order to allow a surgeon to read the display with ease from a distance.

In an embodiment, counter mechanism may be a digital counter including a light source and an optical sensor for cooperating with the light source. The optical sensor may include an electronic eye or fiber optic lead producing a constant infrared beam that is shown on a detector such that the infrared beam or an interruption of the infrared beam can be translated into an electrical signal.

Turning now to FIGS. **9-46**, shaft assembly **104** of surgical clip applier **100** is shown and described hereinbelow. Shaft assembly **104** and the components thereof may be formed of suitable biocompatible materials, such as, for example, stainless steel, titanium, plastics and the like. Shaft assembly **104** includes an outer tube **150** having a proximal end **150***a* supported within knob insert **111**, a distal end **150***b*, and a lumen **150***c* extending therethrough. Shaft assembly **104** further includes an upper housing **152***a* and a lower housing **152***b*, each disposed within lumen **150***c* of outer tube **150**. Outer tube **150** is secured within knob insert **111** by protrusions **111***c* extending from inner surface of knob insert **111***a*, **111***b* and engaging holes **150***d* formed in outer tube **150** (see FIG. **9**). A trip block **154** is disposed within outer tube **150** and proximal of upper housing **152***a*. As seen in FIGS. **43** and **45**, trip block **154** includes a window **154***a* formed in an upper surface thereof.

Shaft assembly **104** further includes a pusher bar **156** slidably interposed between outer tube **150**, and upper housing **152***a* and trip block **154**. Pusher bar **156** includes a distal end **156***a* defining a pusher **156***c* configured and adapted to selectively enter into a window **153***a* formed in upper housing **152***a* (see FIGS. **21** and **22**) and engage/move (i.e., distally advance) clips stored in surgical clip applier **100**. Pusher bar **156** further includes a proximal end **156***b* operatively secured to trip block **154** (see FIGS. **21** and **23**). Pusher bar **156** defines a distal window **156***d* and a proximal window **156***e*.

As seen in FIG. **23**, pusher bar **156** is biased to a proximal position, relative to trip block **154**, by a biasing element **158**, such as for example a compression spring, interposed between a boss **154***a* extending from trip block **154** and a surface of pusher bar **156**. In an embodiment, as seen in FIG. **23**, spring **158** is supported on a tine **156***f* formed in a window **156***g* of pusher bar **156**, wherein a distal end of tine **156***f* slidably extends through boss **154***a* of trip block **154**. Spring **158** is disposed between a base of tine **156***f* and stem **154***a* of trip block **154**.

As best seen in FIGS. **9**, **12**, **43** and **44**, shaft assembly **104** further includes a latch lock-out **160** operatively supported within a channel **154***b* (see FIG. **44**) defined in an underside of trip block **154**. Latch lock-out **160** includes a latch member **162** pivotally supported in channel **154***b* of trip block **154**, and a biasing member **164** securely connected within channel **154***b* of trip block **154** and operatively connected to latch member **162** so as to bias latch member **162**, in a counter-clockwise direction as shown, to a first condition. Latch member **162** includes a distal portion **162***a* defining a shoulder and a proximal portion **162***b* defining a rounded surface **162***b*. Biasing member **164** includes an arm **164***a* in contact with and acting on distal portion **162***a* of latch member **162** to force distal portion **162***a* of latch member **162** radially inward (i.e., towards or in a counter-clockwise direction as shown) and likewise to force proximal portion **162***b* of latch member **162** radially outward (i.e., away or in a counter-clockwise direction as shown).

As best seen in FIGS. **9**, **14**, **43** and **46**, shaft assembly **104** further includes a pusher-bar latch mechanism **166** operatively supported within a channel **153***b* (see FIG. **46**) defined in an underside of upper housing **152***a*. Pusher-bar latch mechanism **166** includes a lock-out bar **168** pivotally supported in channel **153***b* of upper housing **152***a*, and a biasing member **170** securely connected within channel **153***b* of upper housing **152***b* and operatively connected to lock-out bar **168** so as to bias lock-out bar **168**, in a clockwise direction as shown, to a first condition. Lock-out bar **168** includes a distal portion **168***a* operatively connected to biasing member **170**, and a proximal portion **168***b* defining a catch. Biasing member **170** includes a proximal portion **170***b* in contact with and acting on distal portion **168***a* of lock-out bar **168** to force distal portion **168***a* of lock-out bar **168** radially outward (i.e., away from lower housing **152***b* or in a clockwise direction as shown) and likewise to force proximal portion **168***b* of lock-out bar **168** radially inward (i.e., toward lower housing **152***b* or in a clockwise direction as shown).

As seen in FIGS. **27** and **46**, a distal portion **170***a* of biasing member **170** is received in an aperture formed in a retention plate **172**. Retention plate **172** is operatively supported in channel **153***b* of upper housing **152***a* and includes a pair of spaced apart, resilient, distal tangs **172***a*. Tangs **172***a* of retention plate **172** are configured and adapted to selectively engage a backspan of a distal-most surgical clip "C1" (not

shown in FIG. **46**) of a stack of surgical clips "C" retained within surgical clip applier **100**.

As seen in FIGS. **9**, **24**, **25** and **27**, a stack of surgical clips "C" is loaded and/or retained within channel **153***b* of upper housing **152***a* in a manner so as to slide therewithin and/or therealong. As mentioned above, a distal-most surgical clip "C1" of the stack of surgical clips "C" is selectively held in position by tangs **172***a* of retention plate **172**.

Shaft assembly **104** further includes a clip follower **180** slidably supported and/or retained within channel **153***b* of upper housing **152***a*. Clip follower **180** includes a head portion **180***a* disposed behind and in contact with a proximal-most surgical clip "C2" of the stack of surgical clips "C". Clip follower **180** further includes a tail portion **180***b* extending in a proximal direction from head portion **180***a*. Head portion **180***a* defines a ramp **180***c* near a proximal end thereof. In operation, as will be discussed in greater detail below, as clip follower **180** is distally advanced, head portion **180***a* thereof will contact and engage lock-out bar **168** of pusher-bar latch mechanism **166** such that distal portion **168***b* of lock-out bar **168** is cammed or urged in a radially outward direction (i.e., toward upper housing **152***a* or in a counter-clockwise direction as shown) by ramp **180***c* of head portion **180***a* of clip follower **180**.

A biasing member in the form of a compression spring **182** is disposed about tail portion **180***b* of clip follower **180**. Biasing member **182** functions to bias clip follower **180** in a distal direction, thereby applying a distally oriented force on the stack of clips "C". Retainer block **184** includes a flange **184***b* interposed between upper housing **152***a* and trip block **154**.

As seen in FIGS. **9** and **24-26**, shaft assembly **104** further includes a clip retainer plate **186** configured and adapted to under/overlie the stack of surgical clips "C", clip follower **180** and at least a portion of retainer block **184**. As best seen in FIG. **27**, clip retainer plate **186** includes a ramp **186***a* formed near a distal end thereof. As will be described in greater detail below, ramp **186***a* of clip retainer plate **186** functions to engage a backspan of distal-most clip "C1" as distal-most clip "C1" is being advanced by pusher bar **156**. Clip retainer plate **186** snap-fit and/or press-fit engages into channel **153***b* of upper housing **152***a* utilizing tabs **186***b* engaged with elements **153***j* (see FIG. **9**).

As seen in FIGS. **9**, **27**, **31-35**, **39**, **41** and **42**, shaft assembly **104** further includes a wedge plate **188** under/overlying clip retainer plate **186**. Wedge plate **188** includes a substantially tapered distal end **188***a* for selective operative interposition between jaws **106**. As seen in FIGS. **33** and **42**, wedge plate **188** defines a fin or tab **188***b* projecting from a lower surface thereof.

As seen in FIGS. **9**, **28-30**, **34**, **35**, **39**, **41** and **42**, shaft assembly **104** further includes a drive channel **190** positioned adjacent wedge plate **188**. Drive channel **190** includes a pair of side walls **190***a* depending from a backspan **190***b* thereof, in a direction away from wedge plate **188** and into a channel **153***c* defined by lower housing **152***b*. Drive channel **190** further includes a tab **190***c* extending from backspan **190***b*, in the direction of side walls **190***a* (see FIGS. **39** and **41**), an elongate slot **190***d* formed in backspan **190***b* (see FIGS. **39** and **42**), and a cut-out **190***e* formed in one of side walls **190***a* (see FIGS. **39** and **42**).

As seen in FIGS. **9**, **11**, **24**, **26**, **28**, **29**, **31**, **37** and **38**, and as described above, shaft assembly **104** includes a drive bar **140** having a proximal end **140***b* extending into handle assembly **102**, and distal end **140***a* extending below and/or adjacent to a proximal end of wedge plate **188**. Drive bar **140** includes a goose-neck **140***c* (see FIG. **11**) such that distal end **140***a* thereof is on/in a different plane than proximal end **140***b* thereof, and such that at least a portion of distal end **140***a* underlies or is adjacent to drive channel **190**. Distal end **140***a* of drive bar **140** defines an elongate slot **140***d* formed therein. Distal end **140***a* of drive bar **140** further includes a stop **140***h* formed therein at a location proximal of slot **140***d* and extending in a direction away from lower housing **152***b*. Proximal end **140***b* of drive bar **140** includes formations and/or structure **140***f* (see FIG. **11**) configured and adapted to support and/or otherwise retain trip mechanism **192** thereon.

As seen in FIGS. **9**, **11**, **24**, **26** and **43**, shaft assembly **104** further includes a trip mechanism **192** supported in proximal end **140***b* of drive bar **140**, in the manner described above. In particular, trip mechanism **192** includes a trip block **194** configured and adapted for retention in or support on formations and/or structure **140***f* of drive bar **140**, and a trip lever **196** pivotally connected to trip block **194**. Trip mechanism **192** further includes a biasing member **198**, in the form of a compression spring, interposed between trip block **194** and a free end of trip lever **196**, for biasing the free end of trip lever **196** in a direction (i.e., clockwise as shown) toward trip block **154**. As seen in FIG. **11**, trip lever **196** defines a catch **196***a* formed along an upper surface thereof.

As seen in FIGS. **9**, **13**, **34**, **37** and **38**, shaft assembly **104** further includes a slider joint **200** slidably interposed between channel **153***c* of lower housing **152***b* and distal end **140***a* of drive bar **140**. Slider joint **200** includes a body portion **202** and a rod **204** extending therefrom. When properly interposed between channel **153***c* of lower housing **152***b* and distal end **140***a* of drive bar **140**, rod **204** of slider joint **200** extends in a substantially distal direction. Rod **204** of slider joint **200** is slidably passed through a stub **153***d* formed in and extending from channel **153***c* of lower housing **152***b* (see FIG. **38**). Shaft assembly **104** further includes a biasing member **206**, in the form of a compression spring, supported on rod **204** and interposed between stub **153***d* of lower housing **152***b* and body portion **202** of slider joint **200**.

Body portion **202** of slider joint **200** includes a tab **202***a* formed near a proximal end thereof, and configured and adapted for slidably engagement in elongate slot **140***d* of drive bar **140** (see FIGS. **37** and **38**). Body portion **202** of slider joint **200** further includes a pocket **202***b* formed near a distal end thereof, and configured and adapted for receiving tab **190***c* of drive channel **190** therein (see FIG. **29**).

As seen in FIGS. **9**, **15**, **34**, **35** and **37**, shaft assembly **104** further includes a wedge plate rack mechanism **210** operatively interposed between channel **153***c* of lower housing **152***b* and drive channel **190**. Wedge plate rack mechanism **210** includes a wedge plate rack **212** slidably disposed within channel **153***c* of lower housing **152***b*. Wedge plate rack **212** includes a body portion **212***a*, a rack **212***b* extending distally from body portion **212***a*, a tail or rod **212***c* extending proximally from body portion **212***a*, a pocket **212***d* formed in an upper surface of body portion **212***a*, and a stem **212***e* extending from a bottom surface of body portion **212***a*.

Stem **212***e* of wedge plate rack **212** rides within a groove (not shown) formed in a surface of channel **153***c* of lower housing **152***b*. Tail or rod **212***d* of wedge plate rack **212** is slidably passed through a stub **153***e* formed in and extending from channel **153***c* of lower housing **152***b* (see FIGS. **9** and **37**). Wedge plate rack mechanism **210** further includes a biasing member **214**, in the form of a compression spring, supported on rod **212***d* and interposed between stub **153***e* of lower housing **152***b* and body portion **212***a* of wedge plate rack **212**. As seen in FIG. **33**, fin or tab **188***b* of wedge plate **188** is disposed within pocket **212***d* formed in an upper surface of body portion **212***a* of wedge plate rack **212**.

Wedge plate rack mechanism **210** further includes a gear **216** pivotally connected to lower housing **152***b*. Gear **216** includes a set of teeth **216***a* that are in operative engagement with rack **212***b* of wedge plate rack **212**, and an opposed tooth **216***b* operatively engageable with cut-out **190***e* formed in one of side walls **190***a* of drive channel **190** (see FIG. **35**). In operation, as will be discussed in greater detail below, as drive channel **190** is axially displaced in a distal direction, drive channel **190** causes gear **216** to rotate (i.e., in a clockwise direction as shown) and thus causes wedge plate rack **212** to axially move in a proximal direction, or vice-versa.

As seen in FIGS. **9**, **34**, **36** and **40**, shaft assembly **104** further includes a pawl and rack assembly **220** operatively interposed between channel **153***c* of lower housing **152***b* and proximal end **140***b* of drive bar **140**. Pawl and rack assembly **220** includes a rack **222** secured to an underside of drive bar **140** (i.e., interposed between proximal end **140***b* of drive bar **140** and channel **153***c* of lower housing **152***b*) such that rack **222** is movable together with drive bar **140**. Rack **222** includes a plurality of teeth **222***a* interposed between a distal recess **222***b* and a proximal recess **222***c* (see FIG. **36**). Recesses **222***b* and **222***c* are provided to allow a pawl to reverse and advance back over teeth **222***a* of rack **222** when rack **222** changes between proximal and distal movement.

Pawl and rack assembly **220** includes a pawl **224** pivotally connected to lower housing **152***b* by a pawl pin **226** at a location wherein pawl **224** is in substantial operative engagement with rack **222**. Pawl **224** includes a pawl tooth **224***a* which is selectively engageable with teeth **222***a* of rack **222**. Pawl tooth **224***a* is engageable with rack teeth **222***b* to restrict longitudinal movement of rack **222** and, in turn, drive bar **140** within shaft assembly **104** and trigger **108** of handle assembly **102**.

Pawl and rack assembly **220** further includes a pawl spring **228** configured and positioned to bias pawl **224** into operative engagement with rack **222**.

As seen throughout the figures and particularly FIGS. **34** and **35**, shaft assembly **104** further includes a set of jaws **106** operatively supported in a distal end thereof. Jaws **106** include a proximal section **106***b* disposed within a distal end of drive channel **190** and a pair of jaw members **106***c* extending from the distal end of upper and lower housing **152***a*, **152***b*. Each jaw member **106***c* defines a camming surface **106***d* against which a distal edge of drive channel **190** will engage, when drive channel **190** is distally advanced, to urge jaw members **106***c* toward one another. The set of jaws **106** may be configured so as to flex or splay outward in order to receive and/or accommodate a clip "C" that is wider than an at rest inner width distance of jaw members **106***c*. In this manner, the set of jaws **106** have the ability to pass through a 5 mm, 10 mm or fixed size cannula or trocar and be able to accommodate a relatively wider clip "C" so as to engage a relatively wider vessel "V".

As best seen from FIGS. **9**, **27** and **88**, each clip "C" has a pre-formed or un-formed outer width and jaws **106** have a manufactured outer width, wherein the outer width of jaws **106** relative to the outer width of clip "C" results in a ratio approximately less than or equal to 1 to 1.8 (e.g., 1:1.8). The ratio may be established or determined when clip "C" is present within jaws **106** or when clip "C" is not present within jaws **106**.

As seen in FIGS. **9**, **34** and **35**, shaft assembly **104** further includes a substantially U-shaped channel **230** disposed within lower housing **152***b* and operatively connected to a distal end of drive channel **190**. U-shaped channel **230** functions to retain jaw members **106***c* in a substantially aligned orientation with one another during an operation of surgical clip applier **100**.

As seen in FIGS. **16** and **17**, surgical clip applier **100** may include an extension joint housing **232** operatively interposed between upper and lower housings **152***a*, **152***b* of shaft assembly **104** and handle assembly **102**. In this manner, surgical clip applier **100** may be modified to use in surgical procedures requiring a greater depth of insertion of jaws **106**, such as, for example, in bariatric surgery.

It is contemplated for surgical clip applier **100** to operate with stacks of clips "C" of varying sizes. For example, the clips comprising the stack of clips "C" may have a relatively narrow dimension or a relatively wide dimension.

The operation of surgical clip applier **100**, to crimp a surgical clip around a target tissue, such as, for example, a vessel, will now be described. With reference to FIGS. **47-61**, trigger **108** is generally in an uncompressed or unactuated state. As such, yoke **124** of drive assembly **120** is in a retracted position and thus, plunger **134** and drive bar **140** are also in a retracted position.

As seen in FIG. **52**, catch **196***a* of trip lever **196** of trip mechanism **192** is positioned within window **156***e* of pusher bar **156**, and latch member **162** of latch lock-out **160** is maintained biased by a proximal end of pusher bar **156**. Pusher bar **156** is biased to a proximal-most position by biasing member **158**. Also, as seen in FIG. **53**, tooth **224***a* of pawl **226** of pawl and rack assembly **220** is disposed within distal recess **222***b* of rack **222**.

As seen in FIGS. **54**, **55** and **58**, tab **202***a* of body portion **202** of slider joint **200** is located at a distal-most end of elongate slot **140***d* of drive bar **140**. The length of elongate slot **140***d* of drive bar **140** defines a dwell "d" of surgical clip applier **100**.

As seen in FIGS. **56**, **57** and **59**, wedge plate **188** is at a distal-most position, wedge plate rack **212** of wedge plate rack mechanism **210** is at a distal-most position, and tooth **216***b* of gear **216** of wedge plate rack mechanism **210** is disposed within cut-out **190***e* formed in one of side walls **190***a* of drive channel **190**.

As seen in FIGS. **60** and **61**, distal end **188***a* of wedge plate **188** is interposed between jaw members **106***c* of jaws **106**. Also, a distal-most clip "C1" of the stack of clips "C" is held in position by tangs **172***a* of retention plate **172**. As seen in FIG. **60**, proximal portion **168***b* of lock-out bar **168** of pusher-bar latch mechanism **166** is disposed beneath pusher bar **156** and is biased as such by biasing member **170**.

Turning now to FIGS. **62-66**, as trigger **108** is squeezed or actuated from the initial position, during a first stage of an initial stroke, as described above, trigger **108** causes wishbone link **122** to move yoke **124** in a distal direction which, in turn, causes plunger **134** to move distally and to move drive bar **140** distally, via shear pin **142**. As seen in FIG. **63**, as drive bar **140** is moved distally, since catch **196***a* of trip lever **196** of trip mechanism **192** is positioned within window **156***e* of pusher bar **156**, pusher bar **156** is also moved distally. Simultaneously therewith, rack **222** is moved distally causing teeth **222***a* thereof to move over tooth **224***a* of pawl **226** and out of distal recess **222***b* thereof.

As seen in FIG. **63**, distal portion **162***a* of latch member **162** of latch lock-out **160** is pivoted into a window **140***g* formed in drive bar **140** due to the urging of arm **164***a* of biasing member **164**.

As seen in FIGS. **65** and **66**, as pusher bar **156** is distally advanced, pusher **156***c* thereof engages a backspan of a distal-most clip "C1" and advances said distal-most clip "C1" over

ramp **186***a* of clip retainer plate **186** and into channels **106***a* of jaw member **106***c* of jaws **106**.

Turning now to FIGS. **67-80**, as trigger **108** is further squeezed or actuated from the first stage of the initial stroke through a second stage of the initial stroke, as described above, trigger **108** causes wishbone link **122** to further move yoke **124** in a distal direction which, in turn, causes plunger **134** to further move distally and to further move drive bar **140** distally, via shear pin **142**.

As seen in FIGS. **67** and **68**, as drive bar **140** is further advanced distally, drive bar **140** cams against distal portion **162***a* of latch member **162** of latch lock-out **160** and thereby pivots distal portion **162***a* of latch member **162** out of window **140***g* formed in drive bar **140**. As seen in FIGS. **69** and **70**, with catch **196***a* of trip lever **196** of trip mechanism **192** still positioned within window **156***e* of pusher bar **156**, pusher bar **156** is further moved distally. As seen in FIG. **69**, as pusher bar **156** is further distally advanced, pusher **156***c* thereof further advances said distal-most clip "C1" into channels **106***a* of jaw member **106***c* of jaws **106**.

As seen in FIG. **70**, trip lever **196** of trip mechanism **192** is cammed down by camming surfaces **154***b* and **154***c* of trip block **154**, against the bias of biasing member **198**, such that catch **196***a* of trip lever **196** disengages window **156***e* of pusher bar **156**.

As seen in FIGS. **69** and **71**, as distal-most clip "C1" is advanced into jaw members **106***c* of jaws **106**, the stack of clips "C" is distally advanced due to a distal force acting thereon by clip follower **180**, which is being urged distally due to a biasing force exerted on head portion **180***a* of clip follower **180** by biasing member **182**.

As seen in FIG. **72**, as drive bar **140** is moved distally, tab **202***a* of body portion **202** of slider joint **200** is translated through elongate slot **140***d* of drive bar **140**, thereby reducing the length and/or size of dwell "d". Drive bar **140** is advanced distally until, as seen in FIGS. **71** and **72**, stop **140***h* of drive bar **140** abuts against a proximal-most end of drive channel **190**, and until shoulders **140***h* abut against a proximal-most end of side walls **190***a* of drive channel **190**.

As seen in FIGS. **73-75**, once catch **196***a* of trip lever **196** is moved out of engagement with window **156***e* of pusher bar **156**, pusher bar **156** is retracted in a proximal direction due to the biasing force exerted thereon by biasing member **158**. Pusher bar **156** is retracted until pusher **156***a* thereof is positioned proximal of a backspan of a distal-most surgical clip of the stack of clips "C".

As seen in FIG. **76**, as pusher bar **156** is biased to the retracted position, pusher bar **156** cams against latch member **162** of latch lock-out **160** and thereby pivots distal portion **162***a* of latch member **162** (e.g., clockwise as shown) out of window **140***g* formed in drive bar **140**.

As seen in FIGS. **71**, **72**, **77** and **78**, when stop **140***h* of drive bar **140** abuts against a proximal-most end of drive channel **190** and shoulders **140***h* abut against a proximal-most end of side walls **190***a* of drive channel **190**, further distal advancement of drive bar **140** results in distal advancement of drive channel **190**. As drive channel **190** is advanced distally, cut-out **190***e* formed in side wall **190***a* of drive channel **190** cams against tooth **216***b* of gear **216** of wedge plate rack mechanism **210** and urges gear **216** to rotate, i.e., clockwise as shown. Rotation of gear **216** results in proximal displacement of body portion **212***a* of wedge plate rack **212** of wedge plate rack mechanism **210** due to the inter-engagement of the set of teeth **216***a* of gear **216** with rack **212***b* of wedge plate rack **212**.

As wedge plate rack **212** is moved proximally, biasing member **214** is compressed between body portion **212***a* of wedge plate rack **212** and stub **153***e* formed in and extending from channel **153***c* of lower housing **152***b*. Concomitantly therewith, body portion **212***a* also moves tab **188***b* of wedge plate **188** in a proximal direction, thus causing distal end **188***a* of wedge plate **188** to be withdrawn from between jaw members **106***c* of jaws **106**, as seen in FIGS. **79** and **80**. With reference to FIG. **79**, when distal end **188***a* of wedge plate **188** is interposed between jaw members **106***c*, distal end **188***a* of wedge plate **188** functions to maintain jaw members **106***c* spaced apart from one another so as to receive a surgical clip "C1" (see FIG. **80**) therebetween and prevent side-load pressure from impeding clip loading. With reference to FIG. **80**, when distal end **188***a* of wedge plate **188** is withdrawn from between jaw members **106***c*, jaw members **106***c* are capable of being approximated toward one another to form a surgical clip "C1" disposed therebetween.

Turning now to FIGS. **81-94**, as trigger **108** is further squeezed or actuated from the second stage of the initial stroke through a third stage of the initial stroke, as described above, trigger **108** causes wishbone link **122** to further move yoke **124** in a distal direction which, in turn, causes plunger **134** to further move distally and to further move drive bar **140** distally, via shear pin **142**. As seen in FIG. **81**, biasing member **136** is now fully compressed between yoke **124** and cap **144**.

As seen in FIGS. **81** and **82**, as trigger **108** is actuated through the third stage of the initial stroke, actuator plate **128** is distally advanced, in the manner described above, thereby causing stem **130***b* of actuation lever **130** to slidably cam around counter actuation surface **128***c*. In so doing, actuation lever **130** is rotated clockwise to come into contact with a lever or electrical contact **132***d* of processor **132***b* and thus cause processor **132***b* to change the image on display **132***a*. For example, the image on display **132***a* may indicate that a surgical clip "C" has been fired or expelled from surgical clip applier **100**.

As seen in FIGS. **81-84**, **92** and **93**, as trigger **108** is actuated, audible/tactile feedback member **126** functions to create an audible click and/or a tactile vibration, thereby indicating to the user that trigger **108** of surgical clip applier **100** has gone through a complete stroke. In particular, as trigger **108** is actuated, arm **126***a* of tactile feedback member **126** rides over and/or along a rib **103***d* formed in at least one of right side half-section **103***a* and left side half-section **103***b*. As arm **126***a* reaches the end of rib **103***d*, arm **126***a* snaps over the end of rib **103***d* and comes into contact with surface **103***f* of right side half-section **103***a* and left side half-section **103***b*, thereby creating and audible sound and a tactile vibration as arm **126***a* comes into contact with surface **103***f*.

As seen in FIGS. **85-89**, as trigger **108** is actuated through the third stage of the initial stroke, drive bar **140** is further advanced distally, thus causing drive channel **190** to be further advanced distally, in the manner described above. As drive channel **190** is further advanced distally, as seen in FIGS. **85** and **86**, tab **190***c* of drive channel **190**, extending into pocket **202***b* of body portion **202** of slider joint **200**, drags or urges body portion **202** of slider joint **200** in a distal direction, thereby compressing biasing member **206** between body portion **202** and stub **153***d* of lower housing **152***b*.

Also, as drive channel **190** is further advanced distally, as seen in FIGS. **88** and **89**, a distal edge of drive channel **190** engages against camming surfaces **106***d* of jaw members **106***c* thus causing jaw members **106***c* to approximate toward one another and to form surgical clip "C1" interposed therebetween. Since U-shaped channel **230** is fixed to drive channel **190** and moves therewith, U-shaped channel **230** functions to cap drive channel **190** so as to maintain jaw members

106*c* within drive channel **190** during the approximation of jaws members **106***c*. As seen in FIG. **90**, surgical clip "C1" may be formed or crimped onto a vessel "V" or any other biological tissue.

Also, as drive channel **190** is further advanced distally, as seen in FIG. **91**, rack **222** of pawl and rack assembly **220** is moved distally until pawl tooth **224***a* of pawl **224** is disposed within proximal recess **222***c* of rack **222**.

As seen in FIG. **94** and as will be described in greater detail below, as drive channel **190** is withdrawn in a proximal direction, rack **222** of pawl and rack assembly **220** is moved in a proximal direction such that pawl tooth **224***a* of pawl **224** is moved out of proximal recess **222***c* of rack **222** and into engagement with teeth **222***a* of rack **222**. Also, pawl **224** is canted, rotated or rocked about pawl pin **226** causing biasing member **228** to deflect. Biasing member **228** functions to maintain tooth **224***a* of pawl **224** in engagement with teeth **222***a* of rack **222**, as well as to maintain pawl **224** in a rotated or canted position.

Turning now to FIGS. **95-99**, return of trigger **108** to an un-squeezed or unactuated position, is shown. Return of trigger **108** to an un-squeezed or unactuated position is facilitated by the biasing action and forces exerted on plunger **134** by biasing member **136**.

As seen in FIG. **95**, as trigger **108** is returned to the un-squeezed position, wishbone link **122** moves yoke **124** in a proximal direction which, in turn, causes plunger **134** to move proximally and to move drive bar **140** proximally, via shear pin **142**. As seen in FIG. **95**, as drive bar **140** is moved proximally, distal edge **140***h* and stop **140***e* of drive bar **140** are backed away from tab **202***a* of body portion **202** of slider joint **200** thus causing tab **202***a* to translate through elongate slot **140***d* of drive bar **140** and increase the length and/or size of dwell "d". As drive bar **140** is retracted proximally, biasing member **206** urges slider joint **200** in proximal direction thereby acting on tab **190***c* of drive channel **190** to urge drive channel **190** in a proximal direction.

As seen in FIG. **97**, as drive channel **190** is moved in a proximal direction, jaw members **106***c* of jaws **106** return to their un-approximated condition due to the natural spring bias thereof. As seen in FIG. **98**, as drive channel **190** is moved in a proximal direction, cut-out **190***e* formed in side wall **190***a* of drive channel **190** allows gear **216** to rotate, i.e., counter-clockwise as shown. Rotation of gear **216** results in distal displacement of body portion **212***a* of wedge plate rack **212** of wedge plate rack mechanism **210** due to the force of biasing member **214** and the inter-engagement of the set of teeth **216***a* of gear **216** with rack **212***b* of wedge plate rack **212**. As wedge plate rack **212** is moved distally, body portion **212***a* also moves tab **188***b* of wedge plate **188** in a distal direction, thus causing distal end **188***a* of wedge plate **188** to be inserted or reintroduced between jaw members **106***c* of jaws **106**, as seen in FIG. **99**.

Turning now to FIGS. **100-102**, the configuration of surgical clip applier **100**, following application of the last surgical clip "C", is shown. As seen in FIG. **100**, when the last surgical clip "C" is advanced by pusher bar **156** into jaws **106**, head portion **180***a* of clip follower **180** is at a distal-most position due to the urging of biasing member **182**. When head portion **180***a* of clip follower **180** is at a distal-most position, ramp **180***c* of head portion **180***a* cams against and urges distal portion **168***b* of lock-out bar **168** of pusher-bar latch mechanism **166** in a direction counter-clockwise, as shown, toward pusher bar **156** and into distal window **156***d* of pusher bar **156**. With distal portion **168***b* of lock-out bar **168** positioned in distal window **156***d* of pusher bar **156**, when pusher bar **156** is retracted, pusher bar **156** is prevented from moving proximally to the fully retracted position.

As seen in FIG. **101**, since pusher bar **156** is prevented from moving proximally to the fully retracted position by distal portion **168***b* of lock-out bar **168**, as described above, distal portion **162***a* of latch member **162** is rotated counter-clockwise, as shown, into window **140***g* of drive bar **140** by arm **164***a* of biasing member **164**. Latch member **162** is prevented from rotating fully by the abutment of proximal portion **162***b* against an inner surface of shaft assembly **104** and/or outer tube **150**. Distal portion **162***a* of latch member **162** effectively blocks proximal movement of drive bar **140** and thus prevents drive bar **140** from returning to a fully proximal position.

With drive bar **140** prevented from returning to the fully proximal position, as seen in FIG. **102**, rack **222** of pawl and rack assembly **220** is prevented from returning to a fully proximal position. As such, tooth **224***a* of pawl **224** fail to be received within distal recess **222***b* of rack **222** and thus fail to reset. Thus, tooth **224***a* of pawl **224** remains engaged with teeth **222***a* of rack **222**, and pawl **224** remains canted with respect to rack **222**. As such, rack **222** is prevented from moving in a distal direction because rack **222** is wedged by pawl **224** and can not reset itself.

With distal portion **168***b* of lock-out bar **168** positioned in distal window **156***d* of pusher bar **156**, with distal portion **162***a* of latch member **162** rotated into window **140***g* of drive bar **140**, and with tooth **224***a* of pawl **224** remaining engaged with teeth **222***a* of rack **222**, trigger **108** of surgical clip applier **100** is prevented from moving distally and/or proximally and the mechanism is locked.

As seen in FIGS. **103** and **104**, if a user of surgical clip applier **100** attempts to exert an excessive force onto trigger **108**, the excessive force will be transmitted to shear pin **148** via plunger **134**. Since drive bar **140** is prevented from moving distally, the excessive force on plunger **134** is transmitted to shear pin **148**, causing shear pin **148** to fail or break at annular recesses **148***a* thereof. Once shear pin **148** is broken, plunger **134** is capable of moving in a distal direction, however, no force is capable of being transmitted to drive bar **140** via shear pin **148**.

As seen in FIGS. **6-8**, surgical clip applier **100** includes a spring stop **138** disposed within handle assembly **102** which keeps actuator plate **128** from falling distally/proximally when surgical clip applier **100** is held in a vertical orientation. In particular, spring stop **138** is fixedly secured to actuator plate **128** and includes a resilient arm **138***a* that frictionally or snap-fit engages a surface within housing **103**. In this manner, since actuator plate **128** is held in position by spring stop **138**, actuator plate **128** does not freely move in a distal or proximal direction as surgical clip applier **100** is maneuvered to a vertical orientation.

It should be understood that the foregoing description is only illustrative of the present disclosure. Various alternatives and modifications can be devised by those skilled in the art without departing from the disclosure. Accordingly, the present disclosure is intended to embrace all such alternatives, modifications and variances. The embodiments described with reference to the attached drawing figures are presented only to demonstrate certain examples of the disclosure. Other elements, steps, methods and techniques that are insubstantially different from those described above and/or in the appended claims are also intended to be within the scope of the disclosure.

What is claimed is:

1. An apparatus for application of surgical clips to body tissue, the apparatus comprising:

a) a handle assembly;

b) a shaft assembly extending distally from the handle assembly and including an upper housing and a lower housing;

c) a plurality of surgical clips disposed within the shaft assembly;

d) jaws mounted adjacent a distal end portion of the shaft assembly, the jaws including a pair of jaw members movable between a spaced-apart position and an approximated position;

e) a drive bar at least partially disposed within the handle assembly and the shaft assembly, the drive bar being longitudinally movable in response to actuation of a trigger of the handle assembly;

f) a drive channel positioned adjacent the first and second jaw members to move the jaw members from the spaced-apart position to the approximated position; and

g) a wedge plate rack mechanism operatively interposed between a channel of the lower housing and the drive channel, the wedge plate rack mechanism including:

a wedge plate rack slidably disposed within the channel of the lower housing and the drive channel, the wedge plate rack having a body portion, a rack extending distally from the body portion, a tail extending proximally from the body portion, and a stem extending from a bottom surface of the body portion;

a biasing member supported on the tail; and

a gear pivotably connected to the lower housing and engaged with the wedge plate rack such that rotation of the gear in a first direction results in proximal displacement of the wedge plate rack and rotation of the gear in a second direction results in distal displacement of the wedge plate rack, wherein proximal displacement of the wedge plate rack moves the body portion in a proximal direction such that the jaw members are capable of being approximated toward one another to form a surgical clip therebetween and distal displacement of the wedge plate rack moves the body portion in a distal direction such that the jaw members are in the spaced-apart position, wherein the gear translates distal movement of the drive channel into proximal movement of the wedge plate rack and proximal movement of the drive channel into distal movement of the wedge plate rack.

2. The apparatus according to claim **1**, wherein the gear includes at least one first tooth in operative engagement with the wedge plate rack and an at least one second tooth in operative engagement with the drive channel.

3. The apparatus according to claim **2**, wherein a side wall of the drive channel defines a cut-out configured to cam against the at least one second tooth of the gear.

4. The apparatus according to claim **1**, further including a wedge plate slidably supported in the shaft assembly, wherein the wedge plate includes a distal end configured and dimensioned for placement between the jaws when the jaws are in the spaced-apart position and when the drive channel is in a proximal position.

5. The apparatus according to claim **4**, wherein a pocket is formed on an upper surface of the body portion that is in operative engagement with a projection extending from the wedge plate, wherein the body portion and the wedge plate are movable in the same direction.

6. The apparatus according to claim **5**, wherein proximal movement of the wedge plate rack moves the projection of the wedge plate in a proximal direction such that a distal portion of the wedge plate is withdrawn from between the jaws.

7. The apparatus according to claim **1**, wherein a shoulder of the drive bar abuts a proximal end of the drive channel such that distal advancement of the drive bar results in distal advancement of the drive channel.

8. The apparatus according to claim **1**, wherein the biasing member is disposed between the body portion of the wedge plate rack and a stub extending from the channel of the lower housing thereby biasing the wedge plate rack in the distal direction.

9. The apparatus according to claim **8**, wherein the tail of the wedge plate rack is slidably passed through the stub extending from the channel of the lower housing.

10. The apparatus according to claim **1**, wherein the biasing member is a compression spring.

11. An apparatus for application of surgical clips to body tissue, the apparatus comprising:

a) a handle assembly;

b) a shaft assembly extending distally from the handle assembly and including an upper housing and a lower housing;

c) jaws mounted adjacent a distal end portion of the shaft assembly; the jaws including a pair of jaw members movable between a spaced-apart position and an approximated position;

d) a drive channel positioned adjacent the first and second jaw members to move the jaw members from the spaced-apart position to the approximated position;

e) a wedge plate slidably supported in the shaft assembly, wherein the wedge plate includes a distal end configured and dimensioned for placement between the jaw members when the jaw members are in the spaced-apart position and when the drive channel is in a proximal position; and

f) a wedge plate rack mechanism supported in the shaft assembly and including,

a wedge plate rack slidably disposed within the shaft assembly, the wedge plate rack having a body portion, a rack extending distally from the body portion, a tail extending proximally from the body portion, and a stem extending from a bottom surface of the body portion;

a biasing member supported on the tail; and

a gear pivotably connected to the lower housing and engaged with the wedge plate rack such that rotation of the gear in a first direction results in proximal displacement of the wedge plate rack and rotation of the gear in a second direction results in distal displacement of the wedge plate rack, wherein proximal displacement of the wedge plate rack moves the body portion in a proximal direction such that the distal end of the wedge plate is withdrawn from between the jaw members and the jaw members are capable of being approximated toward one another to form a surgical clip therebetween and distal displacement of the wedge plate rack moves the body portion in a distal direction such that the distal end of the wedge plate is reintroduced between the jaw members and the jaw members are in the spaced-apart position, wherein the gear translates distal movement of the drive channel into proximal movement of the wedge plate rack and proximal movement of the drive channel into distal movement of the wedge plate rack.

12. The apparatus according to claim **11**, wherein a plurality of surgical clips is disposed within the shaft assembly, each clip having an outer width.

13. The apparatus according to claim **11**, the wedge plate rack mechanism is operatively interposed between a channel of the lower housing and the drive channel.

14. The apparatus according to claim **11**, wherein the gear includes at least one first tooth in operative engagement with the rack and at least one second tooth in operative engagement with the drive channel.

15. The apparatus according to claim **14**, wherein a side wall of the drive channel defines a cut-out configured to cam against the at least one second tooth of the gear.

16. The apparatus according to claim **11**, wherein the biasing member is disposed between the body portion of the wedge plate rack and a stub extending from the channel of the lower housing thereby biasing the wedge plate rack in the distal direction.

17. The apparatus according to claim **16**, wherein a pocket is formed on an upper surface of the body portion that is in operative engagement with a projection extending from the wedge plate, wherein the body portion and the wedge plate are movable in the same direction.

18. The apparatus according to claim **17**, wherein the biasing member is a compression spring.

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